www.gonano-project.eu

DELIVERABLE

4.3

Evaluation report on the outcomes of the MML platform

GoNano Deliverable 4.3

GoNano has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 768622.

Work Package:	WP4
Deliverable number:	D4.3
Partner responsible:	University of Twente (UT)
Compiling author(s):	Anne M. Dijkstra & Sikke Jansma, UT
Contributing author(s):	Marek Pour and Lenka Hebáková (Technology Centre of the Czech Academy of Sciences, TC CAS), Clare Shelley-Egan, Harald Throne-Holst and Pål Strandbakken (Oslo Metropolitan University, OsloMet), Craig Richmond, Boaz Kogon and Paul Wright (European Office of the Royal Melbourne Institute of Technology, RMIT), Lise Bitsch (Danish Board of Technology Foundation, DBT), Daan Schuurbiers, Hannie van den Bergh and Maud Bomert (De ProefFabriek, DPF), Daniela Pimponi and Andrea Porcari (Italian Association for Industrial Research, AIRI)
Quality assurance:	Lise Bitsch (DBT)
Planned delivery date:	1 February 2020
Actual delivery date:	1 March 2020
Dissemination level:	PU *PU = Public* *PP = Restricted to other programme participants (including the Commission Services)* *RE = Restricted to a group specified by the consortium (including the Commission Services)* *CO = Confidential, only for members of the consortium (including the Commission Services)*

CONTENT

EXECUTIVE SUMMARY

This report describes the evaluation and learnings from the findings of the post-measurements, which were conducted as part of Task 4.3 of the GoNano co-creation process. The task aimed to evaluate and demonstrate how co-creative deliberative processes contribute to public and mutual understanding of nanotechnology, how they contribute to building trust between citizens, between public and private institutions, and how co-creative deliberative processes contribute to increased confidence of companies to invest in new (nano-enabled) technologies.

Therefore, short survey questionnaires after each GoNano co-creation activity were conducted as well as follow-up interviews with different kinds of stakeholders after all co-creation activities were completed.

Early and continuous engagement of all stakeholders was secured by the iterative process of the four different activities. Overall, both citizens and other stakeholders agreed that bringing their perspectives together adds value and insights in what is important to consider when developing nanotechnology applications in the areas of food, health and energy.

Co-creation of knowledge within a responsive R&I system was acknowledged by citizens who valued the co-creation process where they were asked to provide their views. In addition, stakeholders valued the insights from citizens although not all believed in citizens being able to contribute at an equal level. The stakeholders indicated that co-creation contributes to the acceptability of nanotechnology innovations and leads to an increased understanding of other stakeholders' perspectives on nanotechnology and product development. However, they were not convinced whether the co-creation led to actual product development.

The quantitative data showed that a large majority of citizens thought their knowledge and understanding of nanotechnology had increased, and they evaluated nanotechnology applications mainly as positive. Their trust in researchers was high. Stakeholders saw the benefits of getting to know each other and learning from each other's perspectives. In particular, they valued getting new insights and making new contacts. In all, the findings support that the activities contributed to **enhanced public understanding of nanotechnology,** trust and mutual understanding between citizens, and public and private institutions.

To gain more insight in the development of citizens or other stakeholders, in the future, a combination of pre- and post-measurement will facilitate better understanding of what changes in people's views can be described to the project activities or not.

In conclusion, learnings are that co-creation activities as set up in the GoNano project are fruitful ways of getting to know considerations from different types of stakeholders and listening to suggestions from citizens. The data provide a more nuanced understanding of what co-creation entails and provided more context for the perspectives of both citizens and other stakeholders regarding such activities.

1. Introduction

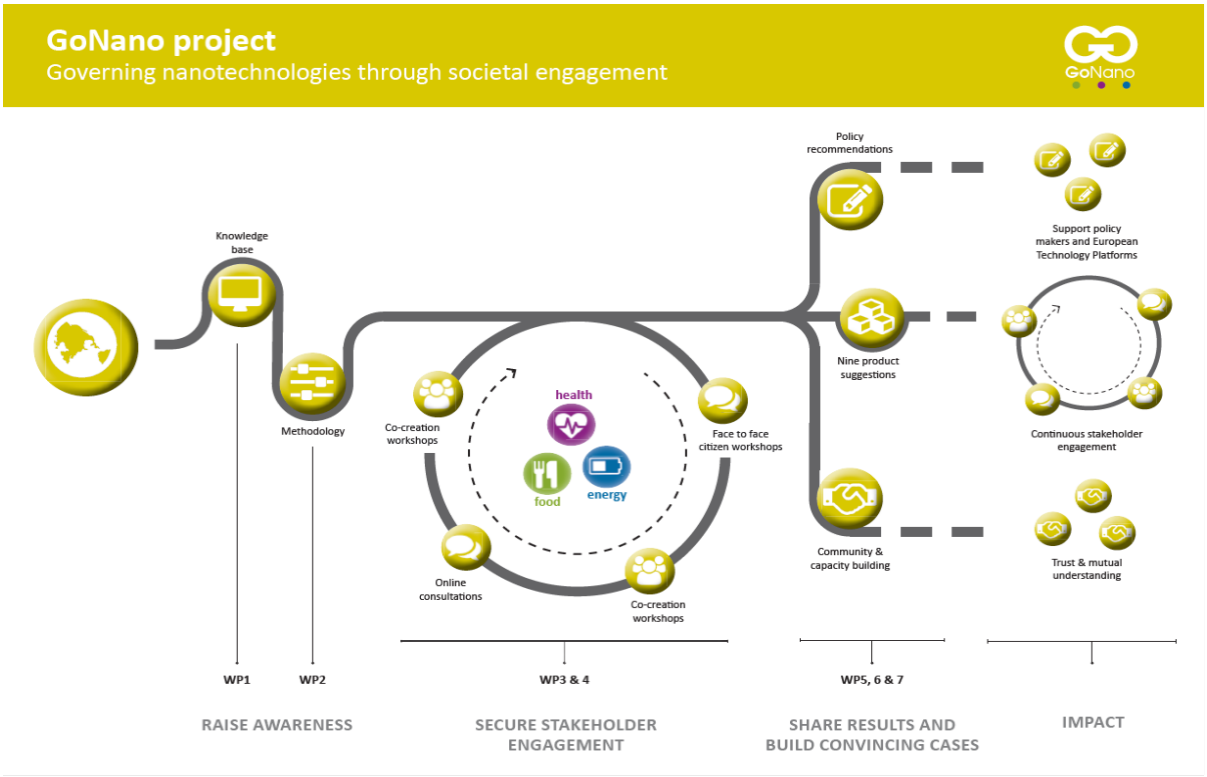
This report describes the findings from the post-measurements which were conducted as part of Task 4.3 of the GoNano project. The task described in this Work Package, first of all, aims to evaluate and demonstrate how co-creative deliberative processes contribute to public and mutual understanding of nanotechnology and how they contribute to building trust between citizens, public and private institutions, and, second, aims to evaluate and demonstrate how co-creative deliberative processes contribute to increased confidence of companies to invest in new (nano-enabled) technologies. In summary, this reports describes the **evaluation and learning from the co-creation process**.

As given in de proposal, post-measurements were conducted by means of short survey questionnaires after each GoNano co-creation activity as well as a few follow-up interviews with different kinds of stakeholders after all co-creation activities were completed.

Objectives of the GoNano Project

Nanotechnologies – the purposeful engineering of matter on the atomic or molecular scale – have given rise to great expectations in recent years, unlocking new research opportunities in areas as diverse as energy, healthcare, electronics, food and construction. At the same time, concerns have been raised about possible unintended consequences of the use of nanomaterials. **The European GoNano project (Governing Nanotechnologies through societal engagement) aims to improve the responsiveness of research and innovation processes to public values and concerns, focusing on the application of nanotechnologies, in the three sectors of food, health and energy.** This goal has been pursued through a structured **co-creation process** involving citizens, stakeholder representatives from civil society organizations, industry, researchers and policy makers across Europe, acting as change agents for the nanotechnology research and innovation system.

The GoNano project is built on the assumption that several types of knowledge are needed to define sustainability, acceptability, and desirability of nanotechnologies. To test this hypothesis, GoNano explored opportunities and barriers for co-creation in the three different thematic areas (food, health and energy), combining face-to-face citizen consultations, stakeholder workshops and online citizen consultations (see Figure 1).



In GoNano, co-creation is defined as follows: "Co-creation activities enable productive collaborations between researchers and societal stakeholders over longer timeframes, focusing on specific nanotechnology research lines, leading to tangible outcomes such as a new research avenue, proposal, product or prototype." (see GoNano Deliverable 2.1 by Bechtold et al., 2018).

Co-creation can enhance responsiveness, which the GoNano project understands as the ability of research and innovation processes to respond and adapt according to changing demands. In doing so, GoNano aimed to reverse the order of innovation by starting with a challenge or key issue in the areas of food, health and energy and then honing in on how nanotechnology might address that challenge. Through the involvement of citizens continually from the start of the innovation process, GoNano anticipates contributions that can serve to make innovation and research more socially relevant.

Co-creation approaches require new forms of collaboration. They outstretch across different disciplines and sectors, and concrete reasoning about specific aspects is necessary. GoNano has established an **iterative process** to integrate societal considerations in nanotechnologies (see also GoNano Deliverables 1.1 by Shelley-Egan et al. (2018), 1.2 by Pimpori et al. (2018) and 2.1 by Bechtold et al. (2018)). In a series of citizen workshops, citizens expressed their wishes and concerns with respect to each of the application areas. In a series of stakeholder workshops, stakeholders explored ways to take these wishes and concerns into account in nanotechnology research and innovation.

More in detail, at the start of the iterative process, the three 'pilot partners' (the Technology Centre of the Czech Academy of Sciences in the Czech Republic, the University of Twente in the Netherlands, and the European Office of the Royal Melbourne Institute of Technology in Spain) organised a series of face-to-face **citizen consultations** in the Czech Republic, the Netherlands and Spain in October/November 2018 (see GoNano Deliverable 3.3 by Hebáková et al (2018).

Building on the outcomes of the citizen consultations, thereupon, the aim of the **first round of stakeholder workshops**, organised in February/ March 2019 (see GoNano Deliverable 4.2 by Schuurbiers et al., 2019), was to come up with concrete 'responsive' design suggestions that could be fed back into ongoing research and innovation activities. The design suggestions fed into the next round of **online citizen consultations**, organised in June/August 2019 (see GoNano Deliverable 3.3 by Pour et al., 2019), which again fed into a **second round of stakeholder workshops**, organised in October/November 2019 (to be submitted, GoNano Deliverable 4.4 by Schuurbiers et al, 2020), that served to evaluate the uptake of the responsive design suggestions of the previous round.

KEY PERFORMANCE INDICATORS

As stated in Deliverable 1.1 from the GoNano project, '**co-creation and mutual learning** offer important **tools and means** of striving for the **realization of a responsible research and innovation process'** (see Deliverable 1.1 by Shelley Egan et al., 2018). To measure impacts of the co-creation process and its line of activities, a set of key performance indicators was formulated in the project proposal. The formulation of these impacts and indicators is based upon the report from the Expert Group on Policy Indicators for Responsible Research and Innovation (Strand et al., 2015).

In this report, the Expert Group proposed indicators that can measure impacts of RRI activities in qualitative and quantitative terms. According to the Expert Group, these indicators, specifically, should focus on **learning from the developing practices and perceptions**, instead of demonstrating causality which is a research task on its own (Strand et al., 2015:15). In addition, the Expert Group stated that the RRI indicator framework with the key performance indicators is **to be seen as a toolbox, more than a tick box**. And, users – like the GoNano project – should use this framework to choose those indicators that fit their RRI performance and make sense.

In the RRI indicator framework, RRI performance depends both on the processes that promote RRI activities and on the effects that these processes have: outcomes. Therefore, acting in a responsible manner relates to performance (expressed in the process and outcomes), perception and key actors. And, consequently, in the RRI indicator framework, a set of criteria for key performance indicators were worked out, related to the five keys of RRI and governance, while for two additional themes sustainability and social justice tentative criteria were described.

For Task 4.3, in particular, key performance indicators were formulated in the Document of Action, which related to performance, that is, process and outcomes; perceptions and key actors, which are in the GoNano co-creation process, citizens and stakeholders. These aimed at the following expected impacts:

- ✓ The **early and continuous engagement** of all stakeholders, specified as:
  - Sustainability, acceptability and desirability of nanotechnology innovation;
  - Alignment with values, needs and expectations of society.
- ✓ A responsive R&I system and **co-production of knowledge**, specified as:
  - Co-creation of knowledge.
- ✓ **Enhanced public understanding of nanotechnology**, trust and mutual understanding between citizens, and public and private institution, and co-creation of R&I, specified as:
  - Enhanced public understanding of nanotechnology;

- Trust and mutual understanding between citizens, and public and private institutions;
- Co-creation of new research and innovations.

The remainder of this report details how these indicators were used in the evaluation with what outcomes.

STRUCTURE OF THE REPORT

The next chapter describes the framework for the evaluation task in relation to RRI indicator framework in more detail. Chapter 3 describes the applied methods of evaluation; while in chapter 4 results from the various data sets will be given. These will be discussed and reflected upon in the final chapter.

2. Framework for evaluation

In this chapter, the framework for evaluation in relation to the RRI indicators will be detailed.

Responsible Research and Innovation

Responsible Research and Innovation (RRI) is often defined as *"a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)"* (Von Schomberg, 2013: xx)

In recent years, RRI has been frequently addressed in academic literature (De Saille, 2015; Rip, 2014; Shelley-Egan et al., 2018). The concept developed out of concerns for emerging technologies such as nanotechnology and implies changing roles and responsibilities for stakeholders and other actors involved in the technology development (cf. Rip, 2014). Therefore, it includes a changing embedding of the technology at hand which includes that for responsible innovation boundaries between science and society will be redefined.

Co-creation

Co-creation and mutual learning offer important tools and means of striving towards responsible innovation. As written in the first GoNano Deliverable 1.1 *Building on the state-of-the art: ex-post evaluation on mutual learning* (Shelley-Egan et al., 2018), co-creation processes as well as engagement methods are based on the rationale that civil society should have a say in decision-making processes regarding the further development and embedding of nanotechnology in society (Krabbenborg & Mulder, 2015), preferably in a bottom-up approach which means that pre-set assumptions will not take over.

Despite that, a top-down co-creation process with invited engagement methods can be needed when direct experience of hazards and awareness is lacking as is the case for nanotechnology (Delgado et al., 2012; Shelley-Egan et al., 2018). Applied co-creation methods may provide the opportunity to influence design and applications early on (see Shelley-Egan et al., 2018). Also, specific relevant publics and stakeholders can be asked to participate, for example because they hold knowledge about the topic at hand (food, health or energy), come from different relevant communities and hold a variety of values. According to Cormick (2012, p. 77) "*There is no simple best way to engage with the public (or publics) on new technologies, other than to engage in as many different ways, and with as many different types of audiences, as is possible.*"

The choice for different sessions for citizens and other stakeholders may avert the risk of power dynamics during engagement activities where stakeholders with their expertise knowledge will take over. In addition, to let participants feel empowered to engage, defining motives and goals clearly, the way the methods are organised, and dealing with different values constructively will be important (Shelley-Egan et al., 2018). In sum, lessons for GoNano from Shelley-Egan et al. (2018):

- Select specific applications and products
- Include a diverse group of stakeholders (next to the usual suspects, e.g. private companies, CSOs, variety of potential consumers and patients) and be as inclusive as possible
- Seek continuous dialogue and engagement

- Use creative formats, e.g. art

Taking into account several of these insights from literature, an iterative co-creation process, is therefore, what was aimed for in the GoNano project by means of the series of activities organised to engage both citizens and stakeholders who take each other's suggestions into consideration and aiming to build responsible relationships.

Building Trust and Mutual Understanding

Further elaboration on what contributes to building a responsible relationship shows that, in co-creation exercises, mutual trust between people and between organisations is key. According to Shelley-Egan et al. (2018), people have to be open and to see the benefits for both, for open innovation and co-creation and within that process, they have to trust each other. Willingness is in this process important which will take time to develop. Increased mutual understanding can then be described as, how co-creative deliberative processes contribute to public and mutual understanding of nanotechnology. According to Yearley (2000), trust is central to the business of science and an essential element of scientific knowledge. Both, trust and credibility are outcomes of interactions and negotiations.

Mobilisation and Mutual Learning Action

Mobilisation and Mutual Learning Actions (MML platform) are a new type of engagement project funded since the 7th Framework Programme. MMLs are intended to encourage a two-way dialogue between researchers and other stakeholders. MMLs can also be seen as a way to encourage a more meaningful engagement of citizens and civil society in research and research based policies. However, at the same time, MMLs are still an evolving concept and it is not completely clear what mutual learning entails and how to engage citizens and society in practice (see also, Mittelstadt et al. 2016 who describe this for the SATORI project). In GoNano, an MML platform is understood as an **instrument for developing collaborative approaches** with various types of stakeholders, as is set out by the iterative co-creation process. In this co-creation process different stakeholders and actors with complementary knowledge and experiences will be brought together, in order to be able to include wishes and concerns of all stakeholders in developing these new technologies on the three areas. In this report, the MML platform is therefore not understood as a physical online platform but as a concept fostering dialogue and engagement. Having said this, for the various activities and the related evaluation methods various types of physical online platforms were used to support the activities, such as EngageSuite for the citizen consultation and stakeholder workshops and Qualtrics for the online consultation.

RRI Indicator framework: Impacts measured with key performance indicators

How RRI will have impacts will be measured by key performance indicators. For the GoNano project, performance indicators were based on the RRI Indicator Framework, (Strand et al., 2015). The list of prioritized indicators suggested by the Expert Group is shown in GoNano Deliverable 8.3 (p.9). The Expert Group worked out these indicators for the five keys of RRI as well as for governance, while they developed tentative indicators for sustainability and social justice/inclusion to be used as a toolbox for evaluation and learning from practices and perceptions. In has to bear in mind, however, that the indicators were originally developed to assess impacts at country levels and it is not yet completely clear how they apply to project level.

As given above, for Task 4.3, qualitative and quantitative key performance indicators were formulated related to performance (process and outcome), perception and key actors in line with the suggestions by the Expert Group (see Table 3.1). The indicators relate to the expected impacts: the **early and continuous engagement** of all stakeholders; **co-production of knowledge**, and **enhanced public understanding of nanotechnology**.

Table 3.1: Key performance indicators for Evaluation and Learning for Task 4.3

Expected impact	GoNano qualification for impact	Key performance indicators
Early and continuous engagement of all stakeholders		
Sustainability, acceptability and desirability of nanotechnology innovation	Participants in the pilot studies (researchers, ETPs, producers, professional users, relevant civil society organisations and consumers/citizens) have defined a common understanding of sustainability acceptability, and desirability of nanotechnology innovation, and how one can work to design R&I products and processes to achieve such an outcome.	90% of the participants in the pilot studies, workshop and online consultations agree to usefulness of common understanding
Alignment with values, needs and expectations of society	Citizens have better understanding of nanotechnology in general, of development conditions of R&I, and of developmental potential and new products in the three areas in particular.	90% of the Researchers, engineers and policy-makers (stakeholders) in the workshops of the pilot studies, agree to knowing how to align product design with societal values, needs and concerns 90% of the citizens in the workshops and online consultations of the pilot studies agree to a better understanding of nanotechnologies, R&I processes and potential of new products
A responsive R&I system and co-production of knowledge		
Co-creation of knowledge	Participants in the pilots will express satisfaction with the co-creative process and the use of different types of knowledge to reach the nanotechnology product suggestions	90% of the participants will agree
Enhanced public understanding of nanotechnology, trust and mutual understanding between citizens, and public and private institution, and co-creation of R&I		
Enhanced public understanding of nanotechnology	Citizens participating in the GoNano pilots will agree to better understanding of nanotechnologies	90% of the participants
Trust and mutual understanding between citizens, and public and private institutions	Participants in the GoNano pilot studies will agree to understanding and trusting each other	80% of the participants
Co-creation of new research and Innovations	Participants in the GoNano pilot studies will agree the process of producing the product suggestions was co-creative. Broad online contributions to the nanotechnology products and policy recommendations	90% of the participants 100 individual commentaries in each of the consulted countries

As stated by the Expert Group, these indicators are aimed at **learning from evaluations and practices**. Therefore, in this evaluation, the qualitative outcomes will be leading the quantitative

outcomes since these will contextualise more in-depth what the learning outcomes are. Furthermore, to take in mind, post-measurements only – as conducted in T4.3 – will not be sufficient to grasp the impacts in full due to the lack of baseline information which, for example, could have been provided by pre-measurements. In the next chapter, the methods used for the evaluation are specified.

3. METHODS USED FOR EVALUATION

This chapter describes the methodology for the evaluations. First, the design and instrument of the evaluations are described, followed by a general description of the participants for each evaluation. A detailed description of the questions and the participants can be found in the method sections of each evaluation in the Annexes.

3.1 MIXED METHODOLOGY

In Task 4.3 a post-measurement was conducted consisting of both quantitative questionnaires as well as a few interviews with different kinds of stakeholders. Such a mixed methodology is considered a valid and valuable research strategy (e.g. Tashakkori & Teddlie, 2003). Mixed methodology amounts to 'good practice' and 'better understanding' (Greene et al., 2001:28) of the topic at hand which entails, according to Greene et al. (2001) the ability to create convergence of results and increased validity, as well as the illumination of more facets of the same co-creation process.

In total, four quantitative questionnaires were handed out evaluating the different co-creation activities. They were distributed after the face-to-face citizen consultation, the first stakeholder workshop, the online citizen consultation, and the second stakeholder workshop. The four questionnaires were designed based on the GoNano indicators which were given as measures for impacts for the GoNano co-creation process, which in turn were based on the indicators as proposed by the Expert Group on RRI (see chapters 1 and 2). The questionnaires aimed to measure knowledge and understanding in nanotechnologies, trust in stakeholders, confidence in the co-creation process, and outcomes of the co-creation process.

3.2 DESIGN OF THE EVALUATION METHODS

In order to ensure consistency and comparability, the four questionnaires had a similar structure and consisted of similar types of questions, However, every questionnaire was adjusted to the context of the specific activity. For instance, the questionnaire for evaluating the face-to-face citizen consultation mainly assessed knowledge and understanding of nanotechnologies, and the questionnaires evaluating the two stakeholder workshops mainly evaluated the outcomes of the co-creation process.

QUESTIONNAIRE 1 – EVALUATION OF THE CITIZEN CONSULTATION

The first questionnaire was distributed after the citizen consultation workshop, and consisted of several sets of questions that were measured on a five-point Likert scale:

- *Knowledge and understanding of nanotechnologies.* Various set of questions (called: constructs), derived from literature, were included to measure impacts (all self-reported) on knowledge and understanding of nanotechnologies. That is, knowledge about nanotechnologies prior to and after the workshop, level of engagement in nanotechnology prior to the workshop, information need about nanotechnologies after the workshop, understanding of applications of nanotechnologies, perceived risks and benefits of nanotechnologies, and attitude towards nanotechnologies. Questions about knowledge and engagement prior to and after the workshop were included to measure impact of the workshop on these topics. The questions about perceived risks and benefits and attitude were included, in order to get a deeper understanding of participants' perceptions, and thereby their understanding of nanotechnologies.

- *Mutual trust and understanding*. This indicator was measured by constructs asking for participants' trust in various actors dealing with nanotechnologies and trust in the participation of various actors in the co-creation process. The actors that were included in these questions were: researchers, policy makers, industry/companies, civil society organisations, and consumer organizations. Additionally, a construct was included about participants' self-efficacy measuring how citizens trusted themselves in dealing with possible risks of nanotechnologies.
- *Co-creation process*. This indicator was measured by two constructs, including the assessment of the organization of the citizen consultation and the quality of the group discussions. With these two constructs the participants' satisfaction with the citizen consultation was measured.
- *Outcomes*. This indicator was measured by one construct, namely the quality of the outcomes of the citizen consultation. Since the citizen consultation was the first activity in the co-creation process, there were no other outcomes to evaluate yet. Citizens could only reflect upon the needs and wishes defined at the consultation.

QUESTIONNAIRE 2 – EVALUATION OF THE FIRST STAKEHOLDER WORKSHOP

The second questionnaire was distributed after the first round of stakeholder workshops, and consisted of sets of questions measured by a five-point Likert scale and additional open questions:

- *Mutual trust and understanding.* This indicator consisted of one open question asking which stakeholders to include in the co-creation process and why, and a construct about the added value of considering needs and values of citizens and stakeholders in an early stage of the development of nanotechnologies. By including this question, information was collected on how participants perceived the importance of including different stakeholder groups in the co-creation process.
- *Co-creation process.* This indicator consisted of questions asking about the quality of the group discussion, and relevance of citizen's messages. The construct about the quality of the group discussion was included to evaluate participants' perception of the stakeholder workshop, and the construct about the relevance of the citizens' messages evaluated the perception of the co-creation methodology of GoNano.
- *Outcomes*. This indicator was measured by two constructs, including the quality of the overall output of the stakeholder workshop and the relevance, novelty and feasibility of the product suggestions. In addition, open questions were included, in order to get a more detailed idea of stakeholders' perceptions of the outcomes.

QUESTIONNAIRE 3 – EVALUATION OF THE ONLINE CONSULTATION

The third questionnaire was part of the online consultation, which consisted of an online questionnaire. In order to make sure that the online consultation could be completed in a reasonable time frame (a maximum of 10 to 15 minutes), a limited number of (evaluation) questions could be included. Impacts were therefore measured by the following indicators:

- *Knowledge and understanding of nanotechnologies.* This indicator was measured by two constructs, and included general knowledge about nanotechnologies and participants' general attitude towards nanotechnologies. These questions were asked at the beginning of the online consultation.
- *Mutual trust and understanding.* As part of the online consultation, participants were asked which stakeholders, in their view, should deal with the safety of different product

suggestions. This question relates indirectly to the level of trust participants have in these stakeholders groups. Additionally, participants were asked whether they expected that their opinion would be included in the further development of the product suggestions, and, also their perception on the relevance of considering needs and values of citizens in an early stage of the development of nanotechnologies was included.

- *Co-creation process*. At the end of the online questionnaire, participants were asked to assess their own confidence in giving their opinion about the product suggestions.
- *Outcomes.* The main part of the online consultation related to the evaluation of the product suggestions, which were formulated as outcomes of the citizen consultation and the first stakeholder workshop. Multiple suggestions were formulated for food, health, and energy (see also D3.3).

QUESTIONNAIRE 4 – EVALUATION OF THE SECOND STAKEHOLDER WORKSHOP

The fourth questionnaire was distributed at the end of the second stakeholder workshop, and, to ensure comparability, was almost identical to the second questionnaire which measured the evaluation of the first stakeholder workshop.

INTERVIEWS – EVALUATION OF THE GONANO CO-CREATION METHODOLOGY

In addition to the questionnaires in all three pilot countries, qualitative data was collected by means of semi-structured interviews. These interviews were conducted with different types of stakeholders who participated in one or more co-creation activities. The semi-structured interviews included various open questions related to the indicators:

- *Knowledge and understanding of nanotechnologies.* The interviewees assessed how the co-creation activities affected the participant's view on nanotechnology and the responsiveness to societal needs and values.
- *Mutual trust and understanding.* The interviewees were asked which stakeholders should be included in the co-creation process, and which were considered less relevant. Additionally, participants were asked how they perceived the involvement of citizens in the co-creation process aiming for a deeper understanding of the perspectives of participants towards other stakeholders.
- *Co-creation process.* The interviewees were asked to both evaluate the activities they participated in, and the co-creation process as a whole. The co-creation process as a whole was evaluated by asking how they understood the concept of co-creation, and whether they thought co-creation was applied in GoNano or not.
- *Outcomes.* As the interviews were the means of evaluation, assessing the outcomes of the GoNano co-creation process were important. Interviewees were asked how they perceived the added value of the co-creation process, and what they thought of the specific outcomes that were formulated based on the co-creation process. Additionally, they were asked whether they would use these outcomes for their own organization, and what they saw as follow-up activities. The latter two questions aimed for insights in the specific actions that interviewees would take based on the co-creation process.

3.3 RESPONDENTS

The questionnaires were translated and distributed in the three pilot countries (the Czech Republic, the Netherlands, and Spain) after every co-creation activity. After the final activity the

interview scheme was distributed and the interviews were conducted. The online citizen consultation was also conducted in Denmark and Ireland, and therefore, the evaluation questions were also distributed in these countries.

The respondents who filled in the questionnaires – except for most of the respondents to the online citizen consultation - were participants who were involved in one or more of the co-creation activities. They had different professional backgrounds (citizens, researchers, businesses, CSOs, policy makers), and different demographic characteristics (gender, age, and level of education) (for more details, see Annexes I to IV). For the interviews, from the group of participants, respondents (interviewees) with different backgrounds were recruited. All of the interviewees participated in one or multiple activities of the co-creation process (see Annex V). The total number of respondents differed for each evaluation (see Table 3.2).

Table 3.2. Number of respondents per country for each evaluation method

Evaluation method	Czech Republic	The Netherlands	Spain	Denmark	Ireland	Total
Questionnaire 1	48	50	21	/	/	**91**
Questionnaire 2	19	23	19	/	/	**63**
Questionnaire 3	156	172	178	195	192	**893**
Questionnaire 4	8	11	9	/	/	**28**
Interviews	5	6	5	/	/	**16**

4. RESULTS FROM THE EVALUATIONS

This chapter describes the results from the evaluations, based on the indicators that were formulated to measure impacts of the GoNano co-creation process.

4.1 KNOWLEDGE AND UNDERSTANDING OF NANOTECHNOLOGIES

"I didn't know much about nanotechnologies, but I have learned quite a lot. Especially the citizen consultation was relevant in this regard. (…) I talked to other citizens as well, and they underlined that the workshop definitely created support and understanding of nanotechnologies for health." (Citizen, the Netherlands, Health)

The citation above is from a citizen who was interviewed and participated in multiple activities during the co-creation process for GoNano. It illustrates the success of GoNano in increasing knowledge and understanding of nanotechnologies. This is supported by the results of the questionnaire of the citizen consultation (see Annex I for a detailed description of the results). In all three pilot countries, the Czech Republic, the Netherlands, and Spain, a large majority of the participants (70% to 80%) reported an increase in their knowledge about nanotechnologies after the workshop. Most participants indicated that they were little informed prior to the workshop, and they felt moderately informed after the workshop.

Furthermore, a similar percentage of the participants (70% to 80%) agreed that the workshop contributed to improving their understanding of nanotechnology in general, and of applications of nanotechnologies in the domain of the pilot country in particular (food in Czech Republic, health in the Netherlands, energy in Spain). Besides the level of knowledge about nanotechnologies, participants were also asked to indicate their level of engagement in nanotechnologies prior to the citizen consultation and their information needs after the workshop. In all three countries, participants agreed that they almost never engaged in nanotechnologies prior to the workshop. They had sometimes heard, read or watched information about nanotechnology, but had seldom searched for information themselves, and had almost never participated in meetings about nanotechnology. After the workshop, the intention of participants to obtain more information about the subject had increased considerably.

To get a deeper understanding of citizens' knowledge about nanotechnologies, participants were asked to describe their association with nanotechnology during the online consultation, provide general feelings (online consultation), indicate their attitude after the citizen consultation, and indicate their perceived risks and benefits of nanotechnologies, also after the citizen consultation. Most participants in the online consultation associated nanotechnology with characteristics, such as, 'advanced size, shape and materials', and described nanotechnology in terms, such as, 'futuristic' and 'advanced technology'. They mainly mentioned positive associations, and the majority (55%) provided a positive, or mostly positive sentiment of the technology. Also, the majority of the participants of the face-to-face citizen consultation (68%) indicated having a positive attitude towards nanotechnology and its applications. In line with this, participants of the face-to-face consultation saw more benefits than risks of nanotechnologies. Although, citizens who participated in the GoNano co-creation process, had little knowledge about nanotechnology before participating, their association with nanotechnology was positive. Also, a large majority of the respondents who participated in the

online consultation showed a positive attitude and they saw more benefits than risks of nanotechnology and its applications.

For stakeholders, the GoNano co-creation process did not change their knowledge and understanding of nanotechnologies, but respondents indicated that it gave them insights in citizens' knowledge and perceptions on this subject. One of the stakeholders who participated in multiple of the co-creation activities in the Czech Republic stated for example: *"The methods introduced [in the GoNano co-creation process] are mostly useful as screening. In other words, it gives us insights in how people understand/misunderstand nanotechnologies"* (Researcher, the Czech Republic, Food).

4.2 Trust and mutual understanding

"Involvement of various stakeholders is beneficial, in order to connect the views from different backgrounds. Concerning bioplastics, the debates are quite conflicting, mainly between researchers and businesses. Although the debates might be sometimes difficult, they are beneficial in the end" (Business representative, the Czech Republic, Food).

With this indicator the aim was to evaluate whether the GoNano co-creation process led to mutual trust and understanding between the stakeholders and citizens. The citation above shows that not every stakeholder group shares a similar perspective on the development and implementation of nanotechnologies, but bringing different perspectives and expertise together can lead to mutual understanding. The stakeholders who were interviewed all agreed that it is valuable to bring together a variety of stakeholders in the co-creation process, including researchers, businesses, CSOs, and policy makers.

That aligns with the findings from the questionnaires of the stakeholder workshops. Nevertheless, most emphasis in the interviews was put on the added value of bringing researchers and businesses together. Various interviewees stated that there is a gap between researchers and businesses. In their view, businesses do not understand much about the research process and the potential risks and benefits of technologies, while researchers do not have a strong feeling for the market and how to develop a technology into a product. The interviewees agreed that the GoNano co-creation process enhanced mutual understanding between these two groups of actors.

In addition, some interviewees noticed the added value of (potential) end-users, and how they brought new insights into the debate. Furthermore, some interviewees mentioned specific insights they gained from other stakeholders. For instance, a post-doc researcher in bio-materials (Researcher, Netherlands, Health) learned from societal partners (social science researchers and CSOs) to think about specific applications of her technology and potential societal challenges and indicated to include them in the future. Another stakeholder (Researcher, Spain, Energy) gained understanding in the decision-making process of research projects on nanotechnologies, and how this affects society's needs and practices. An interviewee (Business representative, the Czech Republic, Food) thought that the co-creation process increased understanding of how other stakeholders perceived their product/technology, and learned about these stakeholders' paradigms.

Next to mutual understanding between stakeholders, also trust and mutual understanding between citizens and stakeholders was evaluated. In the face-to-face citizen consultation, citizens expressed most trust in researchers in dealing with nanotechnology in a responsible way, followed by CSOs and consumer organizations, and industry was trusted the least (see

Annex I). Interestingly, in the Netherlands and Spain, trust in policymakers was considerably high, while citizens from the Czech Republic demonstrated less trust in this actor.

Also in the online consultation, citizens considered researchers as the most important actor to tackle safety issues regarding specific applications of nanotechnologies (see GoNano Deliverable D3.3, pp. 16, 18 and 20). With regard to their perception of stakeholders' intentions in the co-creation process, citizens were neutral to positive in their expectations about whether their opinions voiced in the co-creation process would be taken into account in the further product development. They trusted researchers more in this regard. Nevertheless, a large majority of the citizens (78%) of the online consultation thought it makes sense to consider values and concerns of citizens in the early stages of nanotechnology research (see Annex III). This was illustrated by one of the interviewed citizens: *"I do think it is important to include citizens in these activities [of the GoNano co-creation process]. They give a different type of perspective in the debate and they force experts to stick to the essentials, without getting lost in discussing the details"* (Citizen, the Netherlands, Health).

In both stakeholder workshops rounds, a large majority of the stakeholders thought it made sense to consider the needs and values of citizens and societal actors in an early stage. The interviews gave a different image of stakeholder's perceptions of the added value of engaging citizens. Less than half of the interviewees acknowledged an added value of including citizens in the co-creation process. Those in favour argued that citizens give insights about the public's perception of nanotechnologies and reasons for acceptance or rejection; they ensure that themes are discussed in the co-creation process that are societal embedded; they will be informed about nanotechnology; and they give specific feedback on products that are being developed. Other interviewees, however, did not see great added value of the involvement of citizens, as they thought that a general public lacks the expertise and knowledge to give relevant feedback. Some mentioned, however, that potential users, such as patients, could give relevant input.

4.3 CO-CREATION PROCESS

"Co-creation is a process that brings together different actors, involved in a theme, to develop something. This can be a new format, methodology, or solution to a previous scenario contextualization" (Researcher 1, Spain, Energy).

This citation illustrates how most of the interviewed stakeholders interpreted the term 'co-creation'. They emphasized the involvement of various stakeholders with different expertise and perceptions, the collaboration between those stakeholders in the process, and the creation of something. One of the interviewees explained it as follows: *"By working together, the stakeholders come to new ideas, and the added value of the group is greater than the sum of its parts"* (Citizen, the Netherlands, Health).

When asked whether interviewees saw this reflected in the activities they participated in, most of the interviewees confirmed this view, but they also posed some criticism. The majority of the interviewees thought the activity, or activities, they participated in had a great dynamic, which included interesting stakeholders. They had relevant discussions and the workshops were well-organized. This is also shown by the positive evaluation of the organization and the quality of the discussion of the citizen consultation, and the stakeholder workshops (see Annexes I, II, IV), which all scored above 4.3 on a five-point Likert scale. Furthermore, especially in the Czech Republic and the Netherlands, the interviewees expressed their enthusiasm about meeting new

stakeholders with different backgrounds, and learning about their perspectives on nanotechnology applications, during the GoNano co-creation process. *"The added value [of the co-creation process] consists of meeting a number of actors which we would not usually meet, including the general public"* (Representative of a research and business association, the Czech Republic, Food).

In the interviews, stakeholders were most critical about the 'creation' part. They thought the co-creation process led to interesting, and sometimes, novel ideas and generated awareness for specific applications of nanotechnology. However, at the same time, the process often remained in the conceptualization phase and did not lead to, for example, prototyping or implementation, while the stakeholders thought that should or could also be part of a co-creation process. Some interviewees said that this was due to the lack of a clear problem or problem-owner, at the start of the process. One stakeholder stated, for example: *"During the workshops there was no clear problem-owner. It seemed that a diverse group of stakeholders was brought together around a thematic area, but not to solve a specific problem. Therefore, we spend quite some time to define a problem together, and did not come to a solution. It would have been better to first define a clear problem, and invite relevant stakeholders that potentially can solve this problem"* (CSO, the Netherlands, Health).

4.4 Outcomes and follow-up activities

"The GoNano co-creation process helped to understand how to communicate effectively with stakeholders and helped to get in touch with potential stakeholders who were previously not considered relevant" (Researcher 2, Spain, Energy)

The citation above illustrates the added value and relevance of the GoNano co-creation process. Almost every stakeholder who was interviewed, agreed that GoNano had added value for them and provided relevant outcomes for their organization. During the interviews, the majority of the stakeholders mentioned that they acknowledged added value in getting to know new people, whom they usually would not meet.

Furthermore, more than half of the interviewees mentioned that they gained new insights from the co-creation process, which they had not thought of before. One of the interviewees stated: "*With the co-creation process organized by GoNano, new and relevant insights came up by combining different perspectives. These insights might especially be valuable for researchers who are just starting with their research, such as PhDs and post-docs, as they are still flexible to change their direction"* (Researcher, the Netherlands, Health). The insights vary from specific suggestions for research lines and products, understanding how the general public perceives nanotechnology, to getting into the regulatory challenges of innovations, and the production and research process of innovations.

In addition, some interviewees also mentioned the insights in organizing a co-creation process as relevant lessons learned by participating in GoNano. The added value of the co-creation process for stakeholders, can also be seen by the results of the two questionnaires among this group. A large majority of the stakeholders (70%) was positive about the overall quality of the output of the co-creation session of both stakeholder workshops (see Annexes II and IV).

The aim of GoNano was to come to specific suggestions for research and product development. Stakeholders evaluated the relevance, novelty, and feasibility of the outcomes (suggestions) after both stakeholder workshops in a positive way. Also, in the online consultation, most suggestions were evaluated by citizens as desirable (see D3.3, pp. 17, 19 and 21) However, when

stakeholders were asked about their follow-up actions based on these suggestions, only a few stated that they would take up the suggestions in practice and include them in research or product development.

Some stakeholders added that interesting ideas were formulated during the co-creation process, but that the process did not facilitate prototyping and implementation of these ideas sufficiently. They suggested organising a process with different stakeholders in which the implementation of ideas will be central as a follow-up activity. Nevertheless, a number of stakeholders mentioned undertaking specific actions after the co-creation workshops, including: setting up new partnerships, exploring funding opportunities for further product development, giving a presentation at the organization of one of the participants, further exploring one of the topics discussed at the workshop.

In the next chapter, the results will be discussed and a conclusion will be drawn.

5. Discussion and Conclusion

The evaluation conducted for the GoNano co-creation activities is meant to **learn from developing practices and perceptions** and should be **seen as a toolbox**, more than a tick box. Therefore, what learnings can be derived from the evaluations?

First, insights were collected about an **early and continuous engagement** of all stakeholders and insights in the values, needs and expectations of society as well as the value of co-creation. Early and continuous engagement of all stakeholders was secured by the iterative process of the four different co-creation activities. Overall, both citizens and other stakeholders agree that bringing them together adds value and insights in what is important to consider when designing applications. They indicated that co-creation contributes to the acceptability of nanotechnology innovations and gives insights in what is desirable or not. Additionally, they stipulated that co-creation leads to an increased understanding of other stakeholders' perspectives on nanotechnology and product development. The usefulness of a process such as organized in GoNano is therefore acknowledged broadly. However, it can be discussed whether the activities of GoNano already led, or in the future will lead, to **continuous** engagement and longer-term relationships, in particular, when the GoNano partners are not there to initiate these. A facilitator is needed to bring together the various groups of stakeholders which is shown by the considerable efforts put in by the three pilot countries to organise the activities. A positive remark is that, in the interviews, various stakeholders indicated to have organized various follow-up activities with other stakeholders by means of presentations, meeting each other or other activities or intentions to meet or include other perspectives.

Secondly, **co-creation of knowledge** was expected to lead to a responsive R&I system. The outcomes of the questionnaires showed that the citizens valued the co-creation process where they were asked to provide their views. Citizens gained more knowledge about nanotechnology and specific applications in the areas of food, health and energy. In addition, stakeholders valued the insights from citizens although they not all believed in citizens being able to contribute at an equal level. Therefore, it would be good to raise awareness of the usefulness of engaging societal (citizens) views at an early stage. Some researchers said in the interviews that they highly appreciated the new insights brought by GoNano, such as bringing in societal aspects into their research and their proposals and GoNano helped secure contacts between relevant parties. Others said they gained an increased understanding of the research process and insights in challenges in setting up an anticipatory (safe by design) regulatory framework for nanotechnology developments. The co-creation process has led to new ideas and concepts of product, research, policy and communication suggestions by bringing different stakeholders together. Stakeholders thought the co-creation process succeeded in the conceptualisation and ideation phase of relevant, novel and feasible suggestions. However, some indicated that they did not think the co-creation process facilitated the prototyping and implementation of these suggestions.

Finally, **enhanced public understanding of nanotechnology**, trust and mutual understanding between citizens, and public and private institutions and co-creation of R&I, was aimed at. The quantitative data suggests that a large majority of citizens thought their understanding increased. These are self-reported answers and since a baseline response is lacking the precise rise in understanding cannot be reported. Nevertheless, it does indicate a positive effect of the co-creation process on public understanding of nanotechnology. Citizens evaluated

nanotechnology applications mainly as positive and bringing more benefits than risks, which confirms results from previous studies where citizens also expressed benefits and the values for society (cf. Dijkstra & Critchley, 2016). Citizens' trust in researchers was high, as well as in most other stakeholders with the exception of trust in policy makers in the Czech Republic. Also, other stakeholders saw the benefits of getting to know each other and learning from each other's perspectives. In addition, the series of activities was valued in itself as bringing relevant insights and contacts, which according to interviewees contributed to a co-creative process.

Some critique should be considered as well, since, according to some interviewees, a co-creation process needs more time and more activities then the series organized in GoNano. Also, in the interviews some of the interviewees indicated that, as a whole, the activities should have reached more concrete results. According to one of the interviewees, starting with a real problem and a problem-owner and working from there could have helped. However, the design in the GoNano project was such that, in the first step, ideas from citizens were taken into account. These were not yet the challenges the stakeholders already worked on. Furthermore, the GoNano project was organized based on adding value to the development of nanotechnologies. Therefore, the starting point was not a problem or issue, but nanotechnology applications. There seems to be a mismatch between starting from questions from citizens and starting from problems that stakeholders are working on and where they want input from citizens.

A remark can be made related to the above. A co-creation process may need more time before coming to concrete suggestions. Working with a problem-owner may speed-up the co-creation process. While this may be a valuable – and proven – strategy, it can also be contradictory to taking into account citizens values and needs, as was the aim of the GoNano project. That is something which needs to be balanced and considered in future co-creation activities. Taking citizens' values and needs as a starting point for co-creation, may require a much longer process, or lead to fewer actionable outcomes.

LIMITATIONS

Some limitations are also important to consider. In this case, only post-measurement evaluations have been conducted. However, to gain more insight in the development of citizens or other stakeholders, in the future, a combination of pre- and post-measurement will facilitate better understanding of what changes in people's views can be described to the project activities or not. Pre-measurements, may help to get baseline information about certain aspects, in the future. This may enable establishing clearer relationships between the activities and indicators.

Working with the indicators was a challenging task. When using the indicators as a tick-box, the qualitative indicators are met, as indicated from the results, and the quantitative indicators have not been met. Despite really successful outcomes, as reported in the evaluations, it is almost impossible that 90% of the participants agree to, for example, better understanding. In this respect, indicators could have been more realistic and should have been based on outcomes from previous studies, such as risk perception studies. However, using the indicators as a toolbox, has been more fruitful as described above (see also Wickson & Carew, 2014).

CONCLUSION

In conclusion, learnings are that co-creation activities as set up in the GoNano project are fruitful ways of getting to know considerations from different types of stakeholders and listening to suggestions from citizens.

The data provide a more nuanced understanding of what co-creation entails and provided more context for the perspectives of both citizens and other stakeholders regarding such activities. What also is clear, from the various ways the pilot partners have organised the activities, that there is no one way of co-creation as indicated by some of the interviewees. Which aligns well, with Cormick's (2012) suggestion that it is best to organise a series of activities as diverse as possible in order to build a sustainable science-society relationship.

6. References

BECHTOLD, U., FUCHS, D., BITSCH, L., HEBAKOVA, L., ONDREJ, V., DEGNBOL, D., DIJKSTRA, A., JANSMA, S., SCHUURBIERS, D., BAUER, A. & RICHMOND, C. 2018. Method and manuals for the pilot studies. Towards a GoNano co-creation approach. Deliverable 2.1 of the GoNano project.

BECK, U. 1986. *Risikogesellschaft. Auf dem Weg in eine andere Moderne,* Frankfurt am Main, Suhrkamp.

CORMICK, C. 2012. The complexity of public engagement. *Nat Nano,* 7**,** 77-78.

DE SAILLE, S. 2015. Innovating innovation policy: the emergence of 'Responsible Research and Innovation'. *Journal of Responsible Innovation,* 2**,** 152-168.

HEBÁKOVÁ, L., POUR, M., BITSCH, L., RICHMOND, C., KOGON, B., WRIGHT, P., DIJKSTRA, A., JANSMA, S., SCHUURBIERS, D. & BECHTOLD, U. 2019. Citizen needs and values in relation to nanotechnology in food, energy and health: A report form citizen workshops in the Czech Republic, Spain and the Netherlands. GoNano Deliverable 3.2.

MITTELSTADT, B., COECKELBERGH, M., STAHL, B. & WAKUNUMA, K. 2014. SATORI Deliverable D12.1. Good practice in evaluation, reflection and civil society engagement.

PIMPONI, D., PORCARI, A., MANTOVANI, E., BAUER, A., FUCHS, D., AZOULAY, D., BITSCH, L., DEGNBOL, D., HENRIKSEN, H., SCHUURBIERS, D., VAN DEN BERGH, H., MOORE, V., THRONE-HOLST, H., SHELLEY-EGAN, C., RICHMOND, C., KOGON, B., HEBÁKOVÁ, L., VALENTA, O., JANSMA, S. & DIJKSTRA, A. M. 2018. Stakeholders engagement in nanotechnologies: areas and issues for a dialogue. Deliverable D1.3 of GoNano Project.

PORCARI, A., ZAMAGNI, A., MANTOVANI, E., PIMPONI, D. & BITSCH, L. 2019. External Evaluation Report 1. Deliverable 8.3 from the GoNano project.

POUR, M., HEBÁKOVÁ, L., VANČUROVÁ, I., JANSMA, S., DIJKSTRA, A., RICHMOND, C., SIMONSEN, M. M. & BITSCH, L. 2019. Results of the Online consultation. Gonano deliverable 3.3. Briefing report on the outcomes of the online consultation as input for the second workshop with the professional stakeholders.

REED, M. S., DUNCAN, S., MANNERS, P., POUND, D., ARMITAGE, L., FREWER, L., THORLEY, C. & FROST, B. 2018. A common standard for the evaluation of public engagement with research. *Research For All,* 2**,** 143-162.

RIP, A. 2014. The past and future of RRI. *Life Sciences, Society and Policy,* 10**,** 17.

STRAND, R., SPAAPEN, J., BAUER, M. W., HOGAN, E., REVUELTA, G. & STAGL, S. 2015. Indicators for promoting and monitoring responsible research and innovation: report from the Expert Group on policy indicators for responsible research and innovation.

SCHUCK-ZÖLLER, S., CORTEKAR, J. & JACOB, D. 2017. Evaluating co-creation of knowledge: from quality criteria and indicators to methods. *Advances in Science and Research,* 14**,** 305-312.

SCHUURBIERS, D., HEBÁKOVÁ, L., POUR, M., JANSMA, S., DIJKSTRA, A., RICHMOND, C., KOGON, B., WRIGHT, P., VAN DEN BERGH, H. & BITSCH, L. 2019. Working paper on the designs and outcomes of workshop round 1. GoNano Deliverable 4.2.

SHELLEY-EGAN, C., BOWMAN, D. M. & ROBINSON, D. K. R. 2018a. Devices of Responsibility: Over a Decade of Responsible Research and Innovation Initiatives for Nanotechnologies. *Science and Engineering Ethics,* 24**,** 1719-1746.

SHELLEY-EGAN, C., THRONE-HOLST, H., STRANDBAKKEN, P., SCHUURBIERS, D., JANSMA, S., DIJKSTRA, A. M., BITSCH, L., HENRIKSEN, H., DEGNBOL, D., MO BRONDUM GAD, E., BAUER, A., FUCHS, D., HEBAKOVA, L., VANCUROVA, I., VALENTA, O. & PORCARI, A.

2018b. Building on the state-of-the-art: ex-post evaluation on mutual learning. Deliverable 1.1 of GoNano project.
WENGER, E., TRAYNER, B. & DE LAAT, M. 2011. Promoting and assessing value creation in communities and networks: A conceptual framework.
WICKSON, F. & CAREW, A. L. 2014. Quality criteria and indicators for responsible research and innovation: learning from transdisciplinarity. *Journal of Responsible Innovation,* 1**,** 254-273.

LEGISLATION

Directive 2005/28/EC of 8 April 2005 laying down principles and detailed guidelines for good clinical practice as regards investigational medicinal products for human use, as well as the requirements for authorisation of the manufacturing or importation of such products"

ANNEXES

The Annexes reproduce the reports from the evaluations conducted after each activity. In addition, an evaluation report of the interviews is added:

I. Evaluation report of the citizen consultations
II. Evaluation report of the first round of stakeholder workshops
III. Evaluation report of the online consultation
IV. Evaluation report of the second round stakeholder workshops
V. Evaluation report of the interviews

ANNEX I: EVALUATION REPORT OF THE CITIZEN CONSULTATIONS

1. INTRODUCTION

At the end of the envisioning citizen workshop, a questionnaire was handed out to every participant. The questionnaire is part of a larger evaluation measurement, aiming to evaluate the whole co-creation methodology of GoNano by measuring various Key Performance Indicators (KPIs). Related to the citizen engagement activities, three KPIs were defined:

1. Knowledge and understanding: 90% of the citizens participating in the GoNano pilots will agree to better understanding nanotechnologies.
2. Trust and mutual understanding: 80% of the participants, including citizens, will agree to understanding and trusting each other.
3. Co-creation: 90% of the participants, citizens and stakeholders, will agree that the process of producing product suggestions was co-creative.

The questionnaire that was filled out at the citizen workshop served both as a baseline measurement (e.g., trust in various stakeholders and expectations in co-creation process), and as an evaluation-measurement (e.g., organization of workshop and increase of knowledge and understanding). It consisted of several constructs (existing of three or four items measuring one concept) and a few single-item questions and all were based on five-point-Likert scales. An English questionnaire served as the main document, and the questions were translated in the languages of the pilot country (Dutch, Czech, and Spanish). Every construct that was included in the questionnaire had a Cronbach's Alpha of 0.70 or higher, which is therefore thought to be a reliable measure of the underlying internal consistency of the concept (Field, 2005). Table 1 provides an overview of the concepts and where applicable the reliability measures. Further details will be discussed below.

Table 1: reliability of measures

Concepts or topics in the questionnaire	**Number of items**	**Cronbach's alpha (N= number of respondents)**
Knowledge and understanding		
Level of engagement before the workshop	3	0.76 (N=116)
Knowledge prior and after workshop	2 single items	
Information need after the workshop	3	0.70 (N=117)
Perceived risks and benefits	4	0.80 (N=118)
Attitude	4	0.70 (N=118)
Understanding general and specific application	2 single items	
Trust and mutual understanding		
Self-efficacy – dealing with possible risks	4	0.79 (N=117)
Trust in actors and stakeholders	5 single items	
Expectations of actors and stakeholders	5 single items	
Co-creation		
Quality of the group discussion	3	0.79 (N=119)
Quality of the output	3	0.70 (N=118)
Organisation	4	0.71 (N=114)

1.1 KNOWLEDGE AND UNDERSTANDING

To measure citizen's knowledge of nanotechnology, two single-item questions were included, asking about knowledge about nanotechnology, both prior to the workshop and after the workshop. Furthermore, a construct of three questions was used to indicate the level of engagement of citizens prior to the workshop, and a construct of three questions was used to test the information need after the workshop. Three questions about the level of engagement were formulated as follows: "Before you participated in this workshop, have you ever read, heard or watched information about nanotechnology; have you ever searched for information; and, have you ever participated in meetings about nanotechnology. This engagement construct reported a Cronbach's Alpha of 0.79. Three questions formed the construct for information need: "After this workshop I will search for more information about nanotechnology; I will keep an eye on information about nanotechnology; and, I will search for the latest news about nanotechnology" (Cronbach's Alpha is 0.70).

Furthermore, to get a clearer picture of citizen's understanding of nanotechnology, two single-item questions asked about the participants' increase in understanding of nanotechnology in general and about their increase in understanding of nanotechnology in the pilot theme. Additionally, two constructs with both four questions were included about perceived risks and benefits, and attitude on nanotechnology. Questions about perceived risks and benefits included: "I perceive risks and benefits about nanotechnology in general for myself / the average citizen / society / future generation" (Cronbach's Alpha is 0.80). The four questions about attitude towards nanotechnology are "I feel attracted to developments of nanotechnology; I believe that developments of nanotechnology are important; I feel involved with developments of nanotechnology; and, I am personally interested in developments of nanotechnology" (Cronbach's Alpha is 0.70).

1.2 TRUST AND MUTUAL UNDERSTANDING

To measure trust and understanding of various stakeholders participating in GoNano, we asked the citizens to indicate their trust on a five-point-Likert-scale regarding various actors or stakeholder groups, namely, researchers, policy makers, industry/companies, civil society organizations, and consumer organizations. We included a similar question about citizen's expectations of how the different actors or stakeholder groups will use the outcomes of the citizen workshop. Additionally, we included a construct with four questions about self-efficacy to measure how citizens trusted themselves of dealing with possible risks of nanotechnology. This construct included the questions: "I consider myself able to search for relevant information; I am able to anticipate possible risks ; I am able to react adequate when something goes wrong; and I am able to help others if needed", and reported a Cronbach's Alpha for internal consistency of 0.79.

1.3 CO-CREATION

Three different constructs with each three questions were used to measure co-creation and to evaluate the citizen workshop: quality of group discussion, quality of the output, and organization. Quality of group discussion had a Cronbach's Alpha of 0.73. The questions were: "I felt sufficiently comfortable to voice my opinions during the process; All participants were respectful towards one another; and, The moderators did a good job in ensuring a constructive

process during the discussions". Quality of output reported a Cronbach's Alpha of 0.70, and included: "I am satisfied with the overall quality of the output of the citizen workshop; Despite different opinions we were able to formulate main needs and benefits; and, I am convinced that the needs and benefits formulated today will serve as input for the upcoming stakeholder workshops". Organization of the citizen workshop had a Cronbach's Alpha of 0.71, and consisted of: "The purpose of the citizen workshop was well communicated beforehand; The information material I received beforehand was easy to understand; and, It is clear to me what will be done with the results of the discussions today".

2. Analysis

In this section, first, results per country will be described, followed with an overall conclusion.

2.1 Czech Republic

Knowledge and understanding

A total of 48 citizens participated in the workshop and completed a questionnaire. Participants indicated that they were little informed about nanotechnology prior to the workshop (M = 2.13; SD =0.80), but the indicated knowledge on nanotechnology after the workshop was significantly higher than before (M = 3.38; SD = 0.92; p = .00). Of all participants, 75% thought they were more informed about nanotechnology after the workshop than prior to the workshop, and 25% did not indicate an increase in knowledge. Also, most participants agreed that the workshop contributed to improving their understanding of nanotechnology in general (M = 3.75; SD = 0,53) and of nanotechnology for food applications in particular (M = 3.92; SD = 0,54). For both questions respectively 70% and 80% of the participants agreed that their understanding improved after the workshop.

Participants indicated that they hardly engaged in nanotechnology prior to the workshop (M = 1.91; SD = 0.76). They sometimes heard, read or watched information about nanotechnology (M = 2.51; SD = 0.88), but hardly searched for information about nanotechnology (M = 1.94; SD = 1.07), and almost never participated in meetings about nanotechnology (M = 1.28; SD = 0.85). After the workshop, there was a need to obtain more information about nanotechnology (M = 3.58; SD = 0.52).

Participants reported a moderately positive attitude on nanotechnology (M = 3.6; SD = 0.51). In line with this, they saw more benefits than risks with the development of nanotechnology (M = 3.7; SD = 0.5).

Trust and mutual understanding

Participants assessed actors differently when it comes to trust in whether these actors will deal with nanotechnology in a responsible way. Researchers were trusted the most, while policy makers were trusted the least (See Table 2.1). Also, expectations of how actors will deal with the outcomes of the citizen workshop in the co-creation process, were the highest for researchers, and the lowest for policy makers (see Table 2.1). Nevertheless, the expectations showed a smaller difference than the scores on trust.

With regard to self-efficacy, participants were moderately confident about their ability to act when something happens related to nanotechnology (M = 3.53; SD = 0.54).

Table 2.1: trust and expectations

Actor	Level of trust: mean (SD)	Expectations: mean (SD)
Researcher	3.94 (0.67)	3.90 (0.93)
Policymakers	2.47 (0.72)	2.69 (1.01)
Industry/companies	2.94 (0.98)	3.19 (1.01)
Civil society organizations	3.03 (0.85)	3.09 (0.80)
Consumer organizations	3.40 (0.84)	3.42 (0.85)

Co-creation

The participants were very positive about the organization of the citizen workshop (M = 4.29; SD = 0,45). They were also positive about the quality of the group discussion with a mean score of 4.49 (0.56), and 35% of the participants giving the full score to every item in this construct. Participants were also positive about the quality of the output, but slightly less than on the other constructs (M = 4.10; SD = 0.48).

About one fifth of the participants answered at least one of the open questions (suggestions for the organization of the workshop or final remarks). Most suggestions were about making sure that nanotechnologies and nanoparticles do not cause any harm and are safe enough for the human health as well as for the environment ("Please, pay more attention to the consequences of nanoparticles use when it comes to the environment. Applications will be simply generated by the market..."). Most remarks were about the gratitude of the organization of the workshop and getting information on nanotechnologies in general as well as more concretely in the area of food.

2.2 SPAIN

Knowledge and understanding

A total of 21 participants filled in the questionnaire. Participants indicated that they were little informed about nanotechnology prior to the workshop (M = 2.14; SD =0.96), but the indicated knowledge on nanotechnology after the workshop was significantly higher than before (M = 3.40; SD = 0.68; p = .00). Of all participants, 80% thought they were more informed about nanotechnology after the workshop than prior to the workshop. Also, most participants agreed that the workshop contributed in improving their understanding of nanotechnology in general (M = 4.24; SD = 0.54) and of nanotechnology for energy applications in particular (M = 4.24; SD = 0.63). For both questions 80% of the participants agreed that their understanding improved after the workshop.

Participants indicated that they hardly engaged in nanotechnology prior to the workshop (M = 1.88; SD = 0.77). They rarely heard, read or watched information about nanotechnology (M = 2.35, SD = 1.14), hardly searched for information about nanotechnology (M = 2.10; SD = 1.07), and almost never participated in meetings about nanotechnology (M = 1.14; SD = 0.66). After the workshop, there was a need to obtain more information about nanotechnology (M = 4.13; SD = 0.51).

Participants reported a positive attitude on nanotechnology (M = 4.03; SD = 0.44). In line with this, they saw more benefits than risks with developing nanotechnology (M = 3.89; SD = 0.59).

Trust and mutual understanding

Participants considerably trusted researchers, consumer organizations and civil society organizations in that they will deal with nanotechnology in a responsible way. They also trusted policy makers but to a lesser extent. Industry/companies were trusted the least (See Table 2.2)., Expectations of how actors will deal with the outcomes of the citizen workshop in the co-creation process were the highest for researchers, and the lowest for policy makers (see Table 2.2).

With regard to self-efficacy, citizens indicated that they were confident about their ability to act when something happens related to nanotechnology was above the mid-point scale of 3 (M = 3.7; SD = 0.52).

Table 2.3: trust and expectations

Actor	Level of trust: mean (SD)	Expectations: mean (SD)
Researcher	4.43 (0.68)	4.38 (0.74)
Policymakers	3.24 (1.14)	2.95 (1.02)
Industry/companies	2.95 (1.28)	3.19 (1.29)
Civil society organizations	3.76 (0.83)	3.50 (0.83)
Consumer organizations	4.05 (0.92)	3.71 (1.06)

Co-creation

The participants were very positive about the organization of the citizen workshop, (M = 4.32; SD = 0.38). They were also positive about the quality of the group discussion, with a mean score of 4.79 (0.32), and 62% of the participants giving the full score to every item in this construct, and the quality of the output of the workshop (M = 4.46; SD = 0.44).

About one third of the participants answered at least one of the open questions (suggestions for the organization of the workshop or final remarks). Most of them gave their gratitude for participating in the workshop. One suggestion was made about increasing the dissemination activities of the workshop in advance, and another one about coming up with more specific examples of nanotechnology in energy during the workshop.

2.3 The Netherlands

Knowledge and understanding

In the Netherlands, in total 50 citizens participated in the citizen consultation. Participants indicated that they were little informed about nanotechnology prior to the workshop (M = 2.44; SD =0.95), while the indicated knowledge on nanotechnology after the workshop was significantly higher (M = 3.35; SD = 0.77; p = .00). Of all participants, 70% thought they were more informed about nanotechnology after the workshop than prior to the workshop, 28% did not indicate an increase in knowledge, and one citizen (2%) had the feeling he/she was less informed after the workshop . Also, most participants agreed that the workshop contributed in improving their understanding of nanotechnology in general (M = 3.93; SD = 0.67) and of

nanotechnology for health applications (M = 3.90; SD = 0.65). For both questions more than 75% of the participants agreed that their understanding improved after the workshop.

Participants indicated that they hardly participated in nanotechnology prior to the workshop (M = 2.23; SD = 0.89). They sometimes heard, read or watched information about nanotechnology (M = 2.94, SD = 1), but hardly searched for information about nanotechnology (M = 2.35; SD = 1.2), and almost never participated in meetings about nanotechnology (M = 1.44; SD = 0.91). After the workshop, participants indicated that they felt the need to obtain more information about nanotechnology (M = 3.72; SD = 0.66).

Participants reported a positive attitude towards nanotechnology (M = 4.0; SD = 0.6). In line with this, they saw more benefits than risks regarding the development of nanotechnology (M = 3.8; SD = 0.77).

Trust and mutual understanding

Most actors were trusted to some extent in dealing with nanotechnology in a responsible way. Researchers were among the actors that were trusted the most, while industry/companies were trusted the least (M=2.90; below the midpoint of the scale) (See Table 2.3). Also the participants' expectations of how actors will deal with the outcomes of the citizen workshop in the co-creation process were the highest for researchers and the lowest for industry (see Table 2.3).

With regard to self-efficacy, the scores around the mid-point of the scale showed that citizens did not feel very secure nor insecure about their ability to act when something happens related to nanotechnology (M = 3.2; SD = 0.69).

Table 2.3: trust and expectations

Actor	Level of trust: mean (SD)	Expectations: mean (SD)
Researcher	4.39 (0.61)	3.69 (0.87)
Policymakers	3.65 (0.79)	3.53 (0.84)
Industry/companies	2.90 (0.88)	2.98 (1.00)
Civil society organizations	3.84 (0.90)	3.39 (0.95)
Consumer organizations	3.51 (1.00)	3.39 (0.91)

Co-creation

The participants were very positive about the organization of the citizen workshop, they gave a score between 4 and 5 on a five-point-Likert-scale (M = 4.35; SD = 0.50). They were even more enthusiastic about the quality of the group discussion, with a mean score of 4.8 (0.35), and 68% of the participants giving the full score to every single item in this construct. Participants were also positive about the quality of the output, but slightly less than on the other constructs (M = 4.26; SD = 0.48).

About one third of the participants wrote something down on one of the open questions (suggestions for the organization of the workshop, and final remarks). Most suggestions were about getting more information on nanotechnology and its applications before the workshops. Most remarks were about the gratitude of the organization of the workshop, and the question to stay involved in GoNano.

2.4 Comparison between countries

Knowledge and understanding

In all pilot countries, Czech Republic, Spain and the Netherlands, a large majority of participants (70% to 80%) reported an increase in knowledge about nanotechnology after the workshop: from little informed to moderately informed. In the Netherlands the increase was less than in the other two countries as participants reported to have more knowledge prior to the workshop (see Table 2.4). Furthermore, a similar amount of participants (70% - 80%) agreed that the workshop contributed to improving their understanding of nanotechnology in general, and of applications of nanotechnology in the domain of the pilot country (health in the Netherlands, food in Czech Republic, energy in Spain). In Spain, the participants were a little more convinced of the effect of the workshop on their understanding of nanotechnology than in the other two countries (see Table 2.4).

In the three countries, participants indicated that they hardly engaged in nanotechnology prior to the workshop. Although, in the Netherlands participants engaged slightly more often in nanotechnology than in the other two countries. After the workshop, a majority of the participants indicated that they felt the need to obtain more information about nanotechnology, with the Spanish participants having the highest information need (see Table 2.4).

To get a clearer picture of how participants perceived nanotechnology, we asked about their attitude on nanotechnology in general and their perceived risks and benefits. Participants had quite a positive attitude towards nanotechnology, but in Czech Republic the attitude was a little lower than in the other two countries. Also, participants saw more benefits than risks with the development of nanotechnology, with no significant differences between the three countries.

Trust and mutual understanding

In the Czech Republic, participants were less trusting towards actors than in the other two countries. Although, in all three countries 'researchers' were trusted the most, Dutch and Spanish participants were more positive about them than Czech participants. Policymakers were perceived as relatively trustworthy in the Netherlands, a little less trustworthy in Spain, and not very trustworthy in Czech Republic (see Table 2.4). In the latter country, policy makers were assessed the lowest on their trustworthiness, while in both the Netherlands and Spain the industry/companies received the lowest score. A reason for the lower level of trust in Czech Republic, could be that it is due to the topic of food. From previous studies, we know that citizens are more sceptical towards nanotechnology in the area of food, than regarding other domains (e.g., Capon, Gillespie, Rolfe, & Smith, 2015). Another explanation could be that Czech citizens are more sceptical towards the intentions of professional stakeholders, than the Spanish and Dutch citizens.

With regard to the expectations of how various actors would deal with the outcomes of the citizen workshop, the results show a different picture. Dutch participants had higher expectations of policymakers, than Spanish and Czech participants. Meanwhile in the Czech Republic and Spain the expectations of researchers were higher than in the Netherlands. Except for the policymakers, the Spanish participants had higher expectations of how actors would deal with the outcomes than in Czech Republic and the Netherlands (see Table 2.4).

Co-creation

In all three countries, the participants were very positive about the organization of the citizen workshop. There were no significant differences between the countries . Also, the participants regarded the quality of the group discussions and the quality of output participants as very positive.

Table 2.4: Descriptive results of the three pilot countries regarding KPIs

	The Netherlands N = 50	Czech Republic N = 48	Spain N = 21	Total N = 119
Knowledge and understanding				
Knowledge prior to workshop	2.44 (0.95)	2.13 (0.80)	2.14 (0.96)	2.25 (0.90)
Knowledge after workshop	3.35 (0.77)	3.38 (0.92)	3.40 (0.68)	3.38 (0.82)
Improved understanding of nano in general	3.93 (0.67)	3.75 (0.53)	4.24 (0.54)	3.91 (0.61)
Improved understanding of nano in health/food/energy	3.90 (0.65)	3.92 (0.54)	4.24 (0.63)	3.97 (0.61)
Engagement prior to workshop	2.23 (0.89)	1.91 (0.76)	1.88 (0.77)	2.04 (0.99)
Information need after workshop	3.72 (0.66)	3.58 (0.52)	4.13 (0.51)	3.73 (0.61)
Attitude towards nanotechnology	4.00 (0.60)	3.60 (0.51)	4.03 (1.07)	3.83 (0.57)
Perceived risks/benefits	3.80 (0.77)	3.70 (0.50)	3.89 (0.59)	3.76 (0.64)
Trust and expectations				
Self-efficacy	3.20 (0.69)	3.53 (0.54)	3.70 (0.52)	3.41 (0.63)
Trust in…				
Researchers	4.39 (0.61)	3.94 (0.67)	4.43 (0.68)	4.21 (0.68)
Policymakers	3.65 (0.79)	2.47 (0.72)	3.24 (1.14)	3.09 (0.99)
Industry/companies	2.90 (0.88)	2.94 (0.98)	2.95 (1.28)	2.92 (0.99)
Civil society organizations	3.84 (0.90)	3.03 (0.85)	3.76 (0.83)	3.50 (0.93)
Consumer organizations	3.51 (1.00)	3.40 (0.84)	4.05 (0.92)	3.56 (0.95)
Expectations of…				
Researchers	3.69 (0.87)	3.90 (0.93)	4.38 (0.74)	3.90 (0.90)
Policymakers	3.53 (0.84)	2.69 (1.01)	2.95 (1.02)	3.08 (1.02)

Industry/companies	2.98 (1.0)	3.19 (1.01)	3.19 (1.29)	3.10 (1.09)
Civil society organizations	3.39 (0.95)	3.09 (0.80)	3.50 (0.83)	3.28 (0.88)
Consumer organizations	3.39 (0.91)	3.42 (0.85)	3.71 (1.06)	3.46 (0.91)
Co-creation				
Organization of citizen workshop	4.35 (0.50)	4.29 (0.48)	4.32 (0.38)	4.32 (0.46)
Quality of group discussion	4.80 (0.35)	4.49 (0.56)	4.79 (0.32)	4.67 (0.47)
Quality of output	4.26 (0.48)	4.10 (0.48)	4.46 (0.44)	4.21 (0.52)

REFERENCES

Capon, A., Gillespie, J., Rolfe, M., & Smith, W. (2015). Perceptions of nanotechnologies and trust in stakeholders: A cross sectional study of pulbic, academic, government and business attitudes. *BMC Public Health, 15*, 424-437.

Field, A. (2005). *Discovering Statistics Using spss* (2nd Edition). London: Sage.

ANNEX II: EVALUATION REPORT OF THE FIRST ROUND OF STAKEHOLDER WORKSHOPS

RESULTS OF THE EVALUATION QUESTIONNAIRE OF THE FIRST STAKEHOLDER WORKSHOPS

INTRODUCTION

At the end of the stakeholder workshops in the first round, a questionnaire was handed out to every participant. The questionnaire is part of a larger evaluation measurement, aiming to evaluate the effectiveness of the whole co-creation methodology of GoNano, by measuring two key concepts:

1. Co-creation process: respondents' attitudes towards the workshop and the co-creation process in general;
2. Outcomes co-creation: respondents' perceptions of the outcomes of the co-creation process in general, and the product suggestion in particular.

In total, 63 stakeholders completed the questionnaire: 21 (75% of the stakeholders who participated) from the Netherlands, 23 from Spain, and 19 from the Czech Republic. The following concepts were measured: co-creation process and outcomes co-creation (see Table 1).

Table 1: Concepts, Constructs and items

Key concept	Construct	Questions that were asked in the questionnaire	Cronbach's Alpha
Co-creation process	Quality of group discussion	I felt comfortable and at ease to voice my opinions during the process.	0.74
		All participants were respectful to one another.	
		The moderators did a good job in ensuring a constructive and fair process during the discussions.	
	Relevance of citizens' messages	The citizens' make sense to me	0.76
		I can relate these messages to my own work	
		Today's discussions will help me to consider these messages in the future	
	Early consideration of social needs and values	It makes sense to consider values and concerns of other stakeholders, such as citizens, at early stages of nanotechnology research	0.77
		It could inspire new or unexpected developments	

Outcomes co-creation	Quality of overall output	I am satisfied with the overall quality of the output of the workshop	0.82
		Despite different opinions we were able to reach to consensus	
		I am convinced that the suggestions formulated today will serve as relevant input for the upcoming workshops	
	Outcomes product suggestions (question level)	Relevant	NA
		Novel	NA
		Feasible	NA

CO-CREATION PROCESS

To measure the stakeholders' perspectives on the co-creation process, participants were asked about their view on the quality of discussions during the stakeholder workshop and the quality of the overall output of the workshop.

Participants were very positive about the quality of the group discussion, as this was scored on average with a 4.40 (SD = 0.54) on a 5-point likert-scale. More than 75% of them agreed or strongly agreed that the group discussions were of good quality. In the Netherlands and Spain stakeholders were slightly, but significantly ($p < 0.05$), more positive than in the Czech Republic (see Table 2).

Around 65% of the participants thought the citizens' messages were relevant for the workshop, but they were less positive about them than about the quality of the group discussion (M = 3.84; SD = 0.74). In the Netherlands participants were most positive, followed by Spain and the Czech Republic. In the Netherlands participants were significantly ($p < 0.05$) more positive than in the Czech Republic. Most answers on the open question in the questionnaire asking for an explanation of the opinion on the citizens' messages came from the Netherlands and Spain. Participants from these countries emphasized that it is interesting to listing to others and that society's thoughts are important to take into account. One respondent said for example: "It is important to hear the citizens as they will be the end-users" (Respondent 6 – the Netherlands). Another one stated: "the ideas are interesting and can improve daily life" (Respondent 33 – Spain).

Most stakeholders (more than 70%) thought it makes sense to consider the needs and values of citizens and societal stakeholders in an early stage (M = 4.07; SD=0.80). Participants in the Netherlands and Spain were more convinced about this value, than participants in the Czech Republic.

Participants gave different explanations to the open question in the questionnaire about why early consideration would or not would not be important. A number of them emphasized the importance of early engagement to enhance the acceptance and diffusion of an innovation, and to generate new ideas. One participant said for example: "innovations that are inspired on people's needs will have a better chance to be implemented" (Respondent 17 – the Netherlands). Another underlined: "brainstorming with people from different backgrounds are great to think outside the box" (Respondent 30 – Spain). A few participants thought there was little or no added value for

early engagement, because nanotechnology in its early stages is abstract and theoretical, and the needs and values of the wider public make are not innovative or make little sense. A few other participants underlined that early engagement as being done in the GoNano-project only would make sense when it is very concrete, includes perspectives from stakeholders with different backgrounds, and result in output with real impact.

	Total	The Netherlands	Czech Republic	Spain
	N = 63	N = 21	N = 19	N = 23
*Co-creation process**				
Quality of group discussion	4.40 (0.54)	4.62 (0.39)	4.06 (0.54)	4.52 (0.30)
Relevance of citizens' messages	3.84 (0.74)	4.09 (0.34)	3.40 (0.98)	3.93 (0.60)
Early consideration of societal needs and values	4.07 (0.80)	4.26 (0.60)	3.40 (1.06)	4.28 (0.54)
*Outcomes co-creation**				
Quality overall output	4.05 (0.63)	4.27 (0.65)	3.76 (0.71)	4.08 (0.45)
Outcomes product suggestions				
Relevance		4.19 (0.51)	3.69 (0.67)	3.82 (0.59)
Novelty		3.50 (0.54)	3.47 (0.52)	3.32 (0.49)
Feasibility		3.90 (0.89)	3.56 (0.98)	3.64 (0.49)

Table 2: means scores of the constructs

*Scores are on a five-point scale

OUTCOMES PRODUCT SUGGESTIONS

More than 70% of the participants were positive about the quality of the output of the workshops (M = 4.05; SD = 0.63). Participants in the Netherlands were most positive, followed by Spain, and the Czech Republic. Whereas the participants in the Netherlands were significantly ($p < 0.05$) more positive about the overall output than the participants in the Czech Republic (see Table 2).

In the three countries, different answers were given to the open question in the questionnaire about how the stakeholders could use the output of the workshop in their own area of expertise. In the Netherlands participants emphasized that it was practical input for product development and research development. Furthermore, setting up new collaborations, creating support and awareness was mentioned. One participant mentioned for example that the output of the workshops helped to get "a sharper idea for product development, and go-to-market strategy" (respondent 5, the Netherlands). In the Czech Republic the usefulness of getting information during the workshop and input for possible applications was emphasized. One participant stated: "an idea for a new application came to me, I am sure I will test it" (respondent 62, the Czech Republic). In Spain getting information about nanotechnology and applications, getting input for research and development, and creating awareness about nanotechnology was mentioned. One

participant said for example that the output of the workshop helped to: “steer my future research towards possible applications which have come up during the workshop” (respondent 30, Spain).

Regarding the product suggestions that were formulated as outcome of the workshops, participants in the Netherlands thought the suggestions were relevant and feasible, but they were less convinced of their novelty (see Table 2). In their explanation of the scores of the product suggestions, participants in the Netherlands were especially enthusiastic about the product suggestion of the field lab in the health and policy workshop. All participants of this workshop gave an answer to this question, and explicitly referred to the concreteness of the idea which they thought was very positive. However, some participants questioned the feasibility of the idea. Also, in the other workshops participants were also positive and remarkably they mostly underlined the novelty of the suggestions. One participant said for example: “the focus was on embedding novel products in existing practices. This enhances chances of successful implementation” (respondent 2, the Netherlands).

In the Czech Republic, participants were also positive about the product suggestions, but less positive about than in the participants in the Netherlands regarding the relevance and feasibility (see Table 1). There were not many responses to the open question about the product suggestions. The participants who did give an answer, focused on the process of coming to the product suggestions. One participant said for example: “an interesting sharing of experience” (respondent 61, the Czech Republic). Another one said: “the set-up of the workshop was in wrong way, the public/consumers should have been informed at first and then there should have been a meeting held between the customers and experts” (respondent 54, the Czech Republic).

Also in Spain the participants were less positive about the product suggestions than in the Netherlands. Similar to the other two pilot countries, they rated the relevance of the product suggestions and the feasibility higher than the novelty (see Table 2). When asked for their opinion about the product suggestions in the open question, most participants were critical. They thought not all ideas were very novel, they questioned the impact and feasibility, and thought more time is needed to further elaborate on the suggestions. One respondent said for example: “I am not impressed by the relevance and the novelty of our group proposal. It stays too general” (respondent 39, Spain).

CONCLUSION

Overall, a majority of the participants in all three pilot countries who filled in the questionnaire were positive about the workshop, the co-creation process and the outcomes of the product suggestions. Participants in the Netherlands were most positive, followed by Spain, and then the Czech Republic. In Spain the highest percentage of participants filled in the questionnaire, and in the Czech Republic the lowest percentage of participants.

ANNEX III: EVALUATION REPORT OF THE ONLINE CONSULTATION

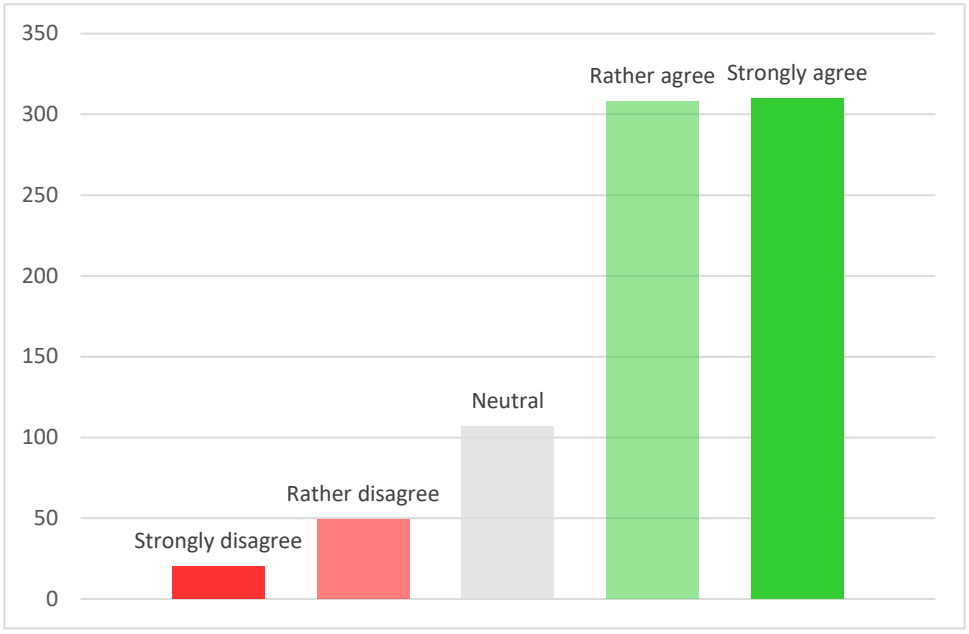
RESULTS ON THE EVALUATION OF THE ONLINE CONSULTATION

FEEDBACK ON CO-CREATION

In the final part of the online questionnaire, respondents were asked not only for providing a basic **demographic information** (such as nationality, gender, education level, age or employment activity), but also feedback on the questionnaire itself and on the co-creation process as such.

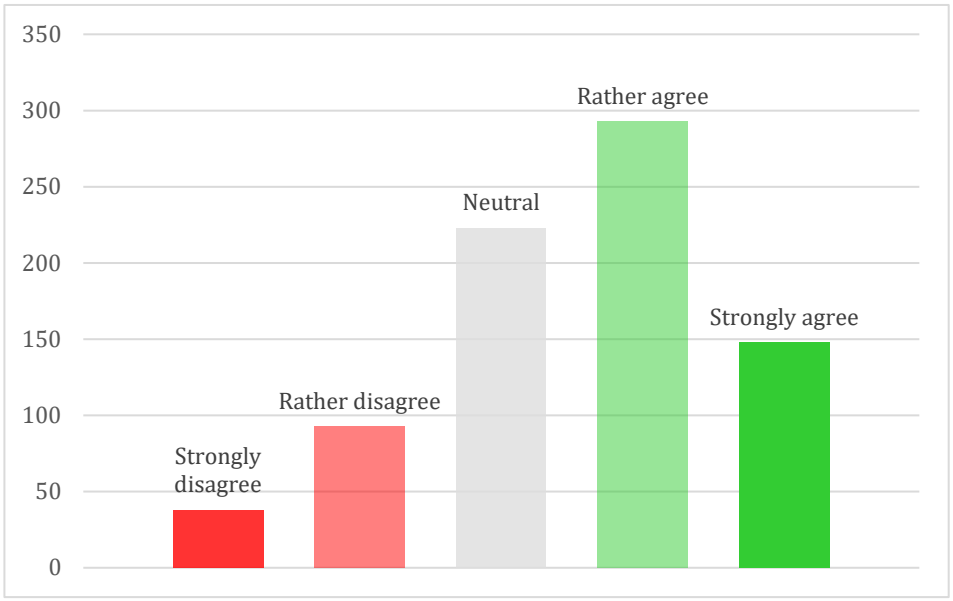
In reaction to the first feedback question on whether they think it makes sense to consider the values and concerns of citizens in the early stages of nanotechnology research, in average 78 % of all the 794 responses strongly or partly agreed (CZ: 81 %; GB 78 %; ES 69 %; NL 83 % and DA 77 %).

Figure 13: Do you think that it makes sense to consider values and concerns of citizens in the early stages of nanotechnology research? (number of responses from all the five countries)



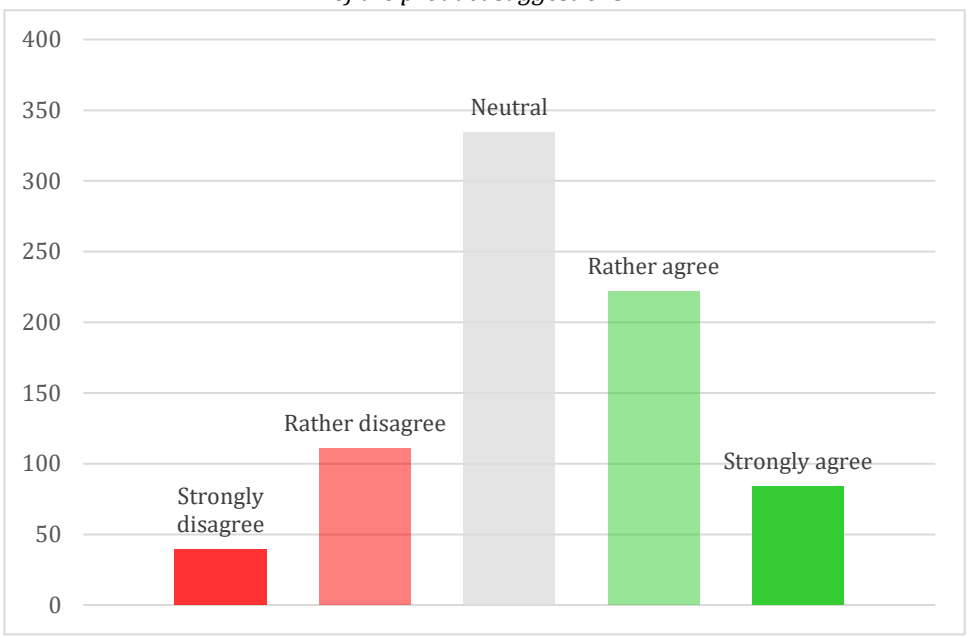
Secondly, respondents largely strongly or partly agreed as well that they feel confident answering the questions about the product suggestions. Respondents from the pilot countries (CZ, ES and NL) were much more positive here (62 % in average) than the ones from the other two countries (GB, DA: 46 % in average) where neither the citizen consultation nor the first stakeholder workshop took place on the nano and food / energy / health. That could illustrate that the self-assessment on confidence are related to the previous awareness of the product suggestions in the earlier stages of the co-creation process.

Figure 14: Did you feel confident answering the questions about the product suggestions? (number of responses from all the five countries)



Lastly, respondents remained neutral or slightly positive on whether their opinions would be taken into account during the further stages of development of the product suggestions. In this context, the fact whether it was the pilot country or not did not play a big difference in reactions.

Figure 15: Do you believe your opinions will be taken into account during the further stages of development of the product suggestions?



ANNEX IV: EVALUATION REPORT OF THE SECOND STAKEHOLDER WORKSHOPS

RESULTS OF THE EVALUATION QUESTIONNAIRE OF THE SECOND STAKEHOLDER WORKSHOPS

INTRODUCTION

At the end of the second round of stakeholder workshops, a questionnaire was handed out to every participant. This questionnaire is part of a larger evaluation measurement, aiming to evaluate the whole co-creation methodology of GoNano, by measuring two key performance indicators:

1. Co-creation process: respondents' attitudes towards the workshop and the co-creation process in general;
2. Outcomes of the co-creation process: respondents' perceptions of the outcomes of the co-creation process in general, and the product suggestions in particular.

In total, 28 stakeholders completed the questionnaire: eleven participants (69% of the stakeholders who participated) from the Netherlands, nine (100% of the stakeholders who participated) from Spain, and eight (53% of the stakeholders who participated) from the Czech Republic. The constructs that were used in this questionnaire were similar to those used in the questionnaire after the first workshops:

Table 1: Indicators, constructs and questions

Key performance indicators	**Construct**	**Questions that were asked in the questionnaire**
Co-creation process	Quality of group discussion	I felt comfortable and at ease to voice my opinions during the process.
		All participants were respectful to one another.
		The moderators did a good job in ensuring a constructive and fair process during the discussions.
	Relevance of outcomes online consultation	The outcomes of the online consultation make sense to me
		I can relate these outcomes to my own work
		Today's discussions will help me to consider these outcomes in the future
	Early consideration of social needs and values	It makes sense to consider values and concerns of other stakeholders, such as citizens, at early stages of nanotechnology research
		It could inspire new or unexpected developments

		It is an informative exercise, but with little impact on the products that will reach the market
Outcomes co-creation	Quality of overall output	I am satisfied with the overall quality of the output of the workshop
		Despite different opinions we were able to reach to consensus
		I am convinced that the suggestions formulated today will serve as relevant input for the upcoming workshops
	Outcomes product suggestions (question level)	Relevant
		Novel
		Feasible

CO-CREATION PROCESS

To measure the stakeholders' perspectives on the co-creation process, participants were asked to provide their views on the quality of discussions during the stakeholder workshop and the quality of the overall output of the workshop.

Table 2: Means scores and standard deviations

	Total N = 28	The Netherlands N = 11	Czech Republic N = 8	Spain N = 9
*Co-creation process**				
Quality of group discussion	4.82 (0.32)	4.76 (0.37)	4.79 (0.22)	4.93 (0.22)
Relevance of citizens' messages	3.83 (0.57)	3.78 (0.34)	3.95 (0.41)	3.91 (0.41)
Early consideration of societal needs and values	3.77 (0.55)	4.33 (0.50)	3.48 (0.54)	4.00 (0.54)
*Outcomes co-creation**				
Quality overall output	4.27 (0.59)	4.27 (0.55)	3.95 (0.45)	4.52 (0.41)
Outcomes product suggestions				
Relevance		3.80 (0.63)	4.38 (0.74)	4.29 (0.76)
Novelty		3.00 (0.67)	3.86 (0.69)	4.14 (0.69)
Feasibility		3.90 (0.74)	3.71 (0.76)	3.57 (1.13)

*Scores are on a five-point Likert-scale

Participants were very positive about the quality of the group discussion, as this was scored on average with a 4.82 (SD = 0.32) on a 5-point Likert-scale (see Table 2). All of them (100%) agreed or strongly agreed that the group discussions were of good quality. Participants also regarded on average the relevance of the outcomes of the online consultation as positive (M=3.83, SD 0.57) with 40% of the participants who agreed or strongly agreed with the relevance of the online consultation. A similar pattern was shown for participants views that early consideration of societal needs and values can add value to innovation in nanotechnologies (M = 3.77; SD = 0.55).

Due to the small sample size no statistical comparisons between the countries are possible. However, comparing average scores, no large differences between the participants from the three countries were found. In the open question about the added value of considering needs and values of stakeholders and citizens in the development of nanotechnologies, comparable views between the participants in the three countries were found. In all three countries, positive remarks were made about the new dimension and new information that had been included to research and innovation, but also less positive remarks were given regarding the limited impact of the workshop and doubts about the role of industry. With regard to the comments on the outcomes of the online consultation, several Dutch and Spanish participants indicated that it gave interesting insights in societal values. Czech participants were more reluctant regarding the added societal value.

OUTCOMES PRODUCT SUGGESTIONS

More than 70% of the participants were positive about the quality of the output of the workshops (M = 4.27; SD = 0.59) (see Table 2).

In the three countries, a large number of stakeholders answered the open question how they could use the output of the workshop in their own area of expertise. Stakeholders in the Netherlands thought the workshop added value, because it generated new ideas, it gave more insights in challenges of researchers and their mind set, it gave insights in the patient's perspective in the development of medical technologies, and it helped developing smart interventions to stimulate the development of the artificial pancreas. In the Czech Republic, stakeholders thought that the workshop led to ideas for further research progress, that it enriched traditional perspectives with new knowledge and information, and that it stimulated valuable debates with other stakeholders. In the Spain, participants thought the workshop helped tuning the messages of dissemination, and increased understanding of how early engagement could help with the development of technologies, the workshop also gave them a practical idea of how specific types of research and product development have an impact on society.

Regarding the action plans (product suggestions) that were formulated as outcome of the workshops, the participants in the Netherlands were positive about the feasibility and relevance of the action plans, but were less convinced of their novelty (see Table 2). In their explanation of the scores of the product suggestions, participants thought the topics discussed were relevant, the action plan focused on societal needs, and provided practical guidelines. However, some participants also mentioned that the content in the action plan was not really new to them.

In the Czech Republic, participants were most positive about the relevance, novelty, and feasibility of the workshop. Two participants commented to the evaluation of the product suggestions. One thought that outcomes were not very useful as nanotechnology is only

applicable in the far future. Another thought that the outcomes are certainly relevant when it comes to the improvement of the environment.

In Spain participants seemed to be especially positive about the relevance and novelty of the outcomes of the workshop, and to a lesser extent, but also positive about the feasibility. However, only two participants provided comments in open question regarding the evaluation of the product suggestions. One participant thought that the ideas were important, but not feasible in the near future. Another participant thought that the workshop helped to further develop the design and idea of a product based on societal needs.

CONCLUSION

Overall, a majority of the participants in all three pilot countries who filled in the questionnaire were positive about the workshop, the co-creation process and the outcomes of the product suggestions. Due to the small sample size, comparisons between the evaluation of the participants in the Netherlands, the Czech Republic and Spain were made based on the average numbers and no statistical comparison was applied. In all, the participants views' from the three countries aligned mostly with each other. Interestingly, participants were on average even more positive about the quality of the workshop and the quality of the output of this workshop than the first workshop. Also, relatively more participants gave an answer to the open questions in this evaluation than in the evaluation of the first workshop, and these comments gave more insights in the respondents' perceptions. However, the sample size was much larger in the first workshop (N = 63) than in this workshop (N = 28).

Annex V: Evaluation report of the Interviews

Evaluation report of the Interviews

To add information to the results of the short questionnaires handed out after each activity, in each pilot country – the Czech Republic, the Netherlands and Spain – follow-up interviews were conducted. The interviews were held with representatives from the stakeholder groups. They participated in one or more of the activities during the co-creation process. In each country, five semi-structured interviews were conducted either face-to-face or via Skype. The interviews lasted around 30 – 90 minutes. Each interview was recorded and summarized anonymously. Interviews were conducted in December 2019 and January 2020 and provided input for the final report.

The interview scheme for the semi-structured interviews consisted of nine questions. Those questions measured knowledge and understanding of nanotechnologies, trust and mutual understanding, the co-creation process, and outcomes, and included the following:

Interview scheme

Process:

1. What do you understand by the term co-creation? What does it mean for you?
2. You participated in the following activities of the GoNano co-creation process (the interviewer should mention the activities): _____ How would you evaluate these activities?

Trust and mutual understanding:

3. How do you perceive the involvement of professional stakeholders in the GoNano co-creation process?
   - Which stakeholders do you believe are essential to include in a co-creation process for the development of (new) nanotechnologies? Why?
   - Which stakeholders are not relevant, or less relevant, in such a process? Why?
4. How do you perceive the involvement of citizens in the GoNano co-creation process?
   a. What should be the role of citizens in the development of new technologies?

Knowledge and understanding of nanotechnologies:

5. How did the GoNano co-creation process affect your views on:
   a. The development of nanotechnologies and its capacity to respond to societal needs and values?
   b. The actors that you've interacted with?

Outcomes:

6. What do you see as the added value of the GoNano co-creation process for developing nanotechnology?
   a. Do you have any suggestions for increasing the added value for you?
7. Were there any outcomes of the GoNano co-creation process that were relevant for yourself and/or your organization?
   a. If yes, what relevance?
   b. If no, why not? And, do you have any suggestions to make it more relevant?

Follow-up activities:

8. How will you use the outcomes or experiences of the GoNano co-creation process in your own work?
9. What, in your view, are logical follow-up steps that should be taken in order to further align the development of nanotechnologies to societal needs and values?

On the next pages summaries of the interviews will be provided.

INTERVIEW 1 – THE CZECH REPUBLIC – REPRESENTATIVE OF RESEARCH AND BUSINESS ASSOCIATION

Meaning of co-creation:
Co-creation is a reasonable term that is being used in the European projects and that represents a valuable process of involvement of various stakeholders.
Evaluation of co-creation activities:
The most interesting point about the activities was to see the difference between the people from business and the people from the research, as they tend to oppose each other and as these meetings seem to always bring some new valuable insights. When it comes to the topics and products discussed by citizens and experts subsequently, these are often well-known and already worked on. However, every event that enables people from research and business to meet, has a significant value. The same goes for meeting the public, to be able to manifest and to discuss the topics of safety, that nano e.g. in its filtering applications doesn't not pose safety threats. One of the most important points exactly raising public´s awareness of the nanotechnologies and their safety aspects.
Involvement of professional stakeholders in the co-creation process:
All the stakeholders involved are important: Companies are important to come up with ideas and specific products. The public and media to be at the process, to learn and understand; and the researchers, so they would criticize and further scrutinize the ideas and products.
Involvement of citizens in the co-creation process:
From our point of view, the most important is to inform the public and to emphasize the topic of nanofibers´ safety, the safety of polymers and monomers that are being regularly tested. To get feedback on what our companies develop. To have the opportunity to inform about the specifics of our nanofibers. To point out the distinctive characteristics of nanoparticles and nanofibers.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
If we have feedback from the wide public and other experts that some of our products are "dead end", then it is important for us to know. It helps us to be able to prioritize what public wants the most and the least. There is a space where we can adapt to it.
Added value GoNano co-creation process:
The added value consists of meeting of a number of actors which we would not usually meet. The wide public is also something rather unknown. The wide audiences often come as people with no experience with the topic whatsoever.
Relevance outcomes GoNano:
The relevance of the outcomes is connected mainly to the topic of Safety (and its discussion).
Follow-up activities:
Nanosafety will be the next big topic. The stakeholders are at the moment sufficiently diverse: Only question would be to include lawmakers on the EU level. It is worth thinking of if not to create a project (and a budget) on how to refer of the safety of the nanotechnologies. What is already being produced now should be communicated appropriately from the safety point of view.
Logical follow-up steps to further align societal needs and values:

I would use the big science communication portals to disseminate the results (e.g. vedavyzkum.cz). Any result or outcome that can lead to wide audiences being more informed. To disseminate documentaries, videos about the issues via media. To intensify the efforts.

INTERVIEW 2 – THE CZECH REPUBLIC – BUSINESS REPRESENTATIVE 1

Meaning of co-creation:
The term co-creation itself does not sound familiar that much.
Evaluation of co-creation activities:
It is certainly beneficial to discuss nanotechnology applications such as nanofilters and smart food packages. Moreover, it seems meaningful to inform the public on the planned products and emerging issues. The wide public should understand what nano means. Also, the more actors involved in the processs, the more possibilities to spread the message. It also seems beneficial from the business point of view.
Involvement of professional stakeholders in the co-creation process:
It is meaningful to talk with every stakeholder. However, it is important to have a clear goal of what is to be done. So, the outcomes of the project should be more factual/substantial and clearly communicated.
Involvement of citizens in the co-creation process:
We find it quite important to consult the results of our efforts and to consult our products and to inform about it. However, it is not as beneficial to ask the wide public on what and especially how to develop such products, since the wide public lacks the expertise to be able to do so.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
Hopefully there would be some influence on the future development.
Added value GoNano co-creation process:
The added value for us is yet still to be revealed, but at least the people should understand the nano-topics and nano-products a bit better.
Relevance outcomes GoNano:
N/A
Follow-up activities:
It is hard to generalize. However, follow-up activities should consist of communication with other experts. In educational activities. There should be practical outcomes: e.g. a workshop on bioplastics and myths surrounding them. Seminars about biodegradability.
Logical follow-up steps to further align societal needs and values:
To align the perception of the public and other actors is not completely possible. The wide public cannot be involved in something that it does not understand. It is difficult to ask wide public when you at the same time have research results claiming that people are not aware of what the processes are behind the development of nano. Therefore, it seems not useful to consult, but rather to inform. Practical continuity of the steps taken should also exist.

INTERVIEW 3 – THE CZECH REPUBLIC – RESEARCHER

Meaning of co-creation:
-//-
Evaluation of co-creation activities:
-//-
Involvement of professional stakeholders in the co-creation process:
It is important to incorporate the experts. It is important to talk with business, since they don't understand the research process and the more detailed picture of the technologies and their benefits and risks that much. From the other point of view, they understand much butter, what makes sense to produce and what does not make sense to produce: The problems with laboratories in connection to bio and nanotechnology is, that there are plenty of technologies/research aims that are already being developed for nearly 30 years, but they are not being commercially produced, as there are problems with e.g. costs and other aspects.
Involvement of citizens in the co-creation process:
It depends on what is the audience, the representativeness of such audience and the "representativeness" in relation to the points discussed. Considering the costs as well, it does not seem so meaningful to involve the public in a deeper way..
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
The methods introduced are mostly useful as screening – in other words, we can understand how people understand/ don't understand nano, so we can explain nano to them. However, such consultations and workshops should contain various groups of citizen (diversified/representative samples).
Added value GoNano co-creation process:
The added value consists in our understanding on how the wide audiences understand nano, and how can we therefore explain them the mechanisms behind it a bit better.
Relevance outcomes GoNano:
The relevance of the event stems from the possibility for the various stakeholders to get to know each other. Moreover, safety is a topic, which people often discuss. For that point it is important to bring all the evidence to the table.
Follow-up activities:
The sum-up of nanotechnologies in the Czech Republic. The sum of knowledge and activities: what is happening in the Czech Republic and what is happening in the EU. To provide the public with information.
Logical follow-up steps to further align societal needs and values:
To follow with screening of the already in-the-field working actors. To inform about the findings and about the steps of the project in general.

INTERVIEW 4 – THE CZECH REPUBLIC – BUSINESS REPRESENTATIVE 2

Meaning of co-creation:
-//-
Evaluation of co-creation activities:

Its beneficial to learn new information from other stakeholders involved. To get into picture of what is happening somewhere else. For us, the most important is the biotechnological part of the discussion.
Involvement of professional stakeholders in the co-creation process:
Involvement of various stakeholders is beneficial – to connect the views from different backgrounds. Concerning bioplastics, the debates are being quite conflicting, mainly between researchers and businesses. But although the debates are being sometimes difficult, they are beneficial in the end. From a general point of view, I would say that in every stakeholder's debate, the actors are defined by their expertise in the way they approach the problem and the way they discuss and what they discuss. Concerning the usefulness of sophisticated nano-packaging systems, they would make sense only in cases when they travel from far, for local products, this would make much less sense.
Involvement of citizens in the co-creation process:
It is certainly relevant to involve the public, to get a feedback on the products that are currently in the development. It is meaningful to consult what already exists, however, not from the beginning. That is given by the fact that nano is such a narrow expert field, that wide audiences would have problems with understanding of the issues, since even the experts have often problems with understanding of the issues connected to nano. And from my experience, even the wider professional audiences have problem with understanding the matter.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
N/A
Added value GoNano co-creation process:
The meeting itself is relevant: opinions of stakeholders are in a way already set up by the workplace of the given stakeholder as every type of work/workplace has its own paradigm to approach the problem.
Relevance outcomes GoNano:
The relevance is contained in the message that the opinions of stakeholders are in a way already set up by the workplace of the given stakeholder: every type of work/workplace has its own paradigm to approach the problem.
Follow-up activities:
To hold a meeting on the compostability/biodegradability of bioplastics. There is a new regulation coming on the EU level (on what polymers can be labeled as natural and what cannot). PHA should be listed out, however for the PLA the opposite is expected.
Logical follow-up steps to further align societal needs and values:
Discussing the topic of safety.

INTERVIEW 5 – THE CZECH REPUBLIC – BUSINESS REPRESENTATIVE 3

Meaning of co-creation:
I perceive the term as a part of the Go-Nano project and its methodology and activities.
Evaluation of co-creation activities:
One of my roles is to try to make a change in the world. Therefore, I try to come to events that seems to be promising a meaningful change, to support projects where money and business is not the main motivation. I see as positive, when something is changing, and something is

evolving. That goes also for things that do not seem to have factual outcomes for me as well. As it can have its practical implications that I am not aware of: E.g. I am happy that something such as smart food package is being developed, although I don't see much connection with the principles of sustainability. When it comes to particles added into food, I would be cautious and skeptical of the potential usefulness of such ideas: It seems to be, that our inability to grow something in a natural way leads us to solve such issues through non-necessary/needless technology that lead to additional problems and complications. From the point of view of its potential benefits, I would see the nanofilters as the most useful application. However, the question of the potential waste liquidation seems to be a question
Involvement of professional stakeholders in the co-creation process:
Every actor has his own world-view and his specific way of thinking. In the professional sphere, although it aspires to be objective, this is often connected to the human factor as well. Meeting of people themselves is important. It can in some time bring benefits that are not self-evident at the moment.
Involvement of citizens in the co-creation process:
It is important to inform the wide audiences of what is being developed and what is happening in the field, but more just for curiosity. It is especially important for the stakeholders to understand on how to inform the public.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
It is already useful to just be a part of the discussions between the actors. That is an influence in itself.
Added value GoNano co-creation process:
The meeting itself is relevant.
Relevance outcomes GoNano:
Experts nowadays seem to be profiled in more and more narrow expertise, therefore the meetings are more and more important. Primarily it is essential to agree in a smaller group of experts within one expertise/field of work internally.
Follow-up activities:
The needs change over time, therefore a plain meeting is what is certainly relevant.
Logical follow-up steps to further align societal needs and values:
If someone would develop something and it contains some safety risks as well, it would be essential to be precautious, to communicate the safe products and to anticipate the possible questions. If I believe my product is safe, then to inform about it in an assertive way.

INTERVIEW 6 – THE NETHERLANDS– CITIZEN

Meaning of co-creation:
Co-creation is about bringing different stakeholders together, who all add value to a product or idea by bringing in their own perspective. The stakeholders come together to new ideas, and the added value of the group is greater than the sum of its parts. It is important that these stakeholders are involved in a non-hierarchical way, and that every participant is actively involved.
Evaluation of co-creation activities:

I was present at three activities of GoNano (citizen consultation, stakeholder workshop 1 – policy and nanotechnology, and stakeholder workshop 2 – nanotechnology and research-industry relations).

- At the citizens consultation, participants had little knowledge about nanotechnology. People with different demographic backgrounds and different perspectives were brought together, and during the day we learned about each other's perspectives. For example, at my table a young person, who is also a diabetes patient, was very enthusiastic about the monitoring device and welcomed the technology, but another older person was worried about the risks of failure of the device. Next to having discussions with the group about the different nanotechnology applications, we also designed our own 'ideal technology'. I enjoyed working on this exercise, but I doubt its usefulness. It would have been more interesting to have an expert present who would tell whether our idea was viable or not.
- At the first stakeholder workshop we came up with the idea of a field lab in a hospital where new nanotechnologies could be displayed and tested with (potential) users. I had the feeling that I could not add much, as I have little knowledge about nanotechnology and the experts who were present knew much more. However, I heard from some experts that they appreciated my input. Nevertheless, in this workshop I felt a great drive among all participants to come to a concrete and new idea. I felt the positive energy in this workshop, which I did not feel in the second stakeholder workshop.
- During the second stakeholder workshop, I felt less energy and less willingness of the participants to come together to new and creative ideas. The outcome of the workshop was less specific. The main reason was that one of the participants, who was an expert in the field (senior researcher) dominated the debate in a negative way. I came up with a new idea, and he cut it short in a destructive way. This gave a negative group dynamic and I felt that I could not add anything to the discussion. Also, I think it is a missed opportunity that we did not further elaborated on the idea of the field lab in the second workshop.

Involvement of professional stakeholders in the co-creation process:

It is important to have a mixture of experts and non-experts present in the co-creation process, and everyone should be treated as an equal partner (non-hierarchical). In the first stakeholder workshop this succeeded the most.

During citizen consultation, no experts were present. On the one hand, I think this was positive as we were not limited in giving our opinion and were all on the same line with regard to the level of knowledge. On the other hand, there was no one who gave a 'reality check' to our discussions, which I think would have enriched the debate. During the third stakeholder workshop, one expert (senior researcher) dominated the debate, and used his authority as an argument in the debate. For me, as a non-expert, it was difficult to bring in another perspective.

Involvement of citizens in the co-creation process:

Although, I did not have the feeling I could add much to the stakeholder workshops, I do think it is important to include citizens in these activities. They give a different type of perspective in the debate, and they force experts to stick to the essentials, and don't get lost in discussing details. Having citizens present at the workshop gives a different kind of energy in the debate (more constructive).

Influence GoNano co-creation process on nanotechnologies and other stakeholders:

I didn't know much about nanotechnologies, but I have learned quite a lot. Especially the citizen consultation was relevant in this regard. Next to discussing scenarios, we also got a tour in the Nanolab, where we learned more about nanotechnology. I talked to other citizens

as well, and the citizen workshop definitely created support and understanding of nanotechnologies for health among citizens.
Added value GoNano co-creation process:
I find it difficult to specify the added value of GoNano for myself. It was interesting to participate in the different activities, and I have gained more knowledge about nanotechnology and its applications in the context of health.
Relevance outcomes GoNano:
I am not sure what the relevance of the outcomes of GoNano is. I think you've experimented with different forms of co-creation activities, and hopefully you have gained more knowledge and insights in this. Although, I do think the workshop have potential to be used more often in the future, I have the feeling you have not found the 'golden egg' yet. My main critique is the follow-up of the different activities. I felt that the second stakeholder workshop was not a logical step after the first. It seemed as if we were going a step back in concreteness and idea generation. In order to make the outcomes of GoNano relevant, you need a 'champion' or 'standard-bearer', who takes up the ideas and continues with it.
Follow-up activities:
A logical follow-up activity would be if Mesa+ takes up the lessons learned from GoNano, and implements the co-creation process in its organization. If there is not an actor, like Mesa+, who takes up these lessons I doubt the usefulness of the whole project.
Logical follow-up steps to further align societal needs and values:
-//-

INTERVIEW 7 – THE NETHERLANDS– POLICY MAKER

Meaning of co-creation:
Co-creation is an open process, in which stakeholders with various backgrounds are present. They define a common goal and are in dialogue with each other, and explore how each of them can contribute to the common goal and what their role is in this regard. Co-creation exists of different phases, including knowledge creation, valorization, and implementation. Different types of stakeholders and people are relevant at each phase. In GoNano the focus was mainly on the first phase: knowledge creation. Also, co-creation should not be approached as a method, but as a system, in which the technology development cycle is included and hierarchical lines between different stakeholders have been removed. A common goal should be formulated with the different stakeholders to aim for, everyone should have the same 'power' in the process, but stakeholders can have different roles. An interesting development to follow in this regard is the Green Deal. Right now it is a number of loose statements and different tasks and responsibilities, but it can only work through a co-creation process with everyone on board.
Evaluation of co-creation activities:
All three co-creation sessions were inspiring and led to relevant and concrete insights: - From the first stakeholder workshop on nanotechnology and diabetes, I learned that business developers still have a technology push mindset, and that the patient/citizen perspective should be part of the business canvas. - I thought the second stakeholder workshop was the best example of co-creation. With all participants present at the workshop, we came to the idea of a field lab where new

nanotechnologies can be shown and experienced by (potential) users. This is a great and innovative idea, and deserves more attention. It would have been interesting to organize a follow-up workshop based on this idea. However, I realize that it is difficult to et people involved in the discussion around the field lab as there might initially not be an actor who feels responsible for the valorization and implementation of this idea. GoNano, or more specifically the organizing party of the first workshop, could take the responsibility of facilitating the follow-up of the workshop, and define together with the stakeholders their role. It should be made clear that there is not one problem owner, but that the participants together are the problem owner.

- In the third stakeholder workshop, the discussion became very concrete as it focused specifically on the Artificial Pancreas. It was interesting to hear different perspectives on the development of the AP (based on an EU certified device and based on data). It was also relevant and interesting to hear about the (lack) of regulations in this regard.

Involvement of professional stakeholders in the co-creation process:

All stakeholder groups are relevant to include in the co-creation process. However, in the different stakeholder workshops I missed the perspective of the 'real' policy maker, the one who is working at the ministry. I can imagine that it is difficult to include them in the process, as they might have problems with giving their opinion which deviates from current regulations. Therefore, it is important to create 'safe environments', where everyone can talk freely with each other (without being held responsible for their statements and opinions).

Involvement of citizens in the co-creation process:

Having the perspective of citizens as a starting point is an interesting angle, as you make sure that the themes discussed in the co-creation process have are societal embedded. For me it was surprising that citizens focused on diabetes, I would have expected that they would mainly focus on cancer research. By using citizens' input as a starting point, you ensure that they are being heard and you give them the feeling that their opinion matters (democratization and legitimation).

Influence GoNano co-creation process on nanotechnologies and other stakeholders:

GoNano has given me some interesting insights regarding involving stakeholders in the co-creation process:

- The importance of emphasizing the user perspective in the development of novel nanotechnologies for health. Especially the business developers and researchers sometimes argue too much from the product/technology point of view – 'technology push'.
- Necessity to come together multiple times for the same theme, and to specify the different roles of the different stakeholders in the co-creation process. This should be done with the stakeholders. For example, in the session about the field lab, everyone was enthusiastic about the idea and specific action points were formulated. However, the roles of the different participants was not specified. Further, a second workshop on this theme was necessary to further develop the idea, and define steps for valorization and implementation. The organizers of GoNano could have facilitated this second workshop.
- Difficulty of keeping stakeholders involved in the different phases of the co-creation process. I've had the same experience (already 10 years ago) with working groups and platforms. There needs to be a clear facilitating actor, but also an explicit role description of the other actors. Participation in the co-creation process is voluntary, but not without obligation. After the first workshop, you could have asked participants whether they want to continue their participation in the co-creation process and how they see their role in this regard.

Added value GoNano co-creation process:

Different aspects were relevant for me:

- Getting to know new people. After the second stakeholder workshop a representative of ZoNNW (who was present as well) asked me to give a talk about new medicines; - It confirmed the lessons learned with NanoNextNL about the importance of SafebyDesign and regulatory preparedness. The discussion on data driven health technology, for example, showed me that the regulatory framework is not up-to-date, and that developments are going much faster in this area than in hardware medical devices. - During the workshops visualizations of nanotechnology and health, made by an artist, were displayed in the room as well. I realized how important visualizations of abstract technologies are, and the impact they can have. Not only in pictures of technologies, but also in the design of the technology itself.
Relevance outcomes GoNano:
-//-
Follow-up activities:
It is important to develop some tools that can be distributed to different parties who continue with the co-creation process. GoNano how co-creation can help by generating new ideas. A follow-up step should be how to valorize these ideas into products and come to implementation. It would be interesting to continue with the lessons of GoNano in a new European project, but than take it a few steps further to the implementation phase in the co-creation process. The starting point should be a (visual) toolbox developed based on the experiences and outcomes of GoNano.
Logical follow-up steps to further align societal needs and values:
It would be interesting to focus on the implementation phase in the co-creation process (not only idea generation), and include different stakeholders in this phase as well.

INTERVIEW 8 – THE NETHERLANDS– RESEARCHER

Meaning of co-creation:
Difficult to define, but for herself co-creation is collecting perspectives of different parties and stakeholders to further develop and improve a research line and or research proposal.
Evaluation of co-creation activities:
The co-creation activities were very useful for the post-doc researcher Based on the first stakeholder workshop the post-doc researcher got insights from both a technical and societal perspective, which was a 'game changer' for her. From the technical side, she got information from researchers from the measurements and bi-medical side, while her own background is in materials and engineering. The researcher provided her information about various issues to take into account when further developing her research line. Societal stakeholders, CSOs and social science researchers, raised relevant questions about the potential applications, potential user groups, potential societal issues and forced her to frame her research in an understanding way. The post-doc research collected all insights, and integrated most of these in a new research proposal. Unfortunately the post-doc researcher could not be present at the second workshop, but she still thought it was relevant for her. The challenge she faces with further developing her research is attracting industry as a collaborating partner. Based on the output she gained some insights and guidelines of how to do this.
Involvement of professional stakeholders in the co-creation process:

The post-doc researcher thought it was very relevant to have researchers with different backgrounds being present at the process. Also, industrial partners are useful, as they can help with framing her research in an attractive way and providing advice on how to involve business and industry in research at an early stage. Furthermore, the post-doc researcher saw great added value with including 'societal partners' (social science researchers, CSOs) in the co-creation process, as they helped her to think about specific applications and potential societal challenges. The post-doc researcher did not think that policy makers were for her relevant in the early stage of her research. They might give advice with where to focus on when writing a research proposal, but for connecting it to the institutional framework, the research is in a too early phase.
Involvement of citizens in the co-creation process:
Regarding the involvement of citizens, the post-doc researcher did not see any direct added value of including them as ' citizens' in the co-creation process. However, she also emphasized that stakeholders are citizens as well, and do not only give input or argue from their professional point of view, but also from their personal point of view. The only advantage of including citizens in the process would be that the researcher would be even more forced to frame her research in an easy understanding way.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
GoNano has given her the insights of the relevance of including people from different backgrounds both on a technical and societal level. She regards the co-creation process as an orchestra with different instruments, by bringing them together and harmonizing them in a framework shaped by the moderators/organizers (directors of the orchestra), great results (music) can be achieved.
Added value GoNano co-creation process:
Co-creation is a very valuable exercise for nanotechnology researcher. Every researcher, should be confronted with societal needs and values every now and then. Many nanotechnology researchers spend most of their time in the lab, focusing on their specific research, and forget to make the connection to society. With a co-creation process organized by GoNano, new and relevant insights come at the table by combining different perspectives. These insights might even be more valuable for researchers who just start their research (PhDs, Post-docs), as they are still flexible to change their directions. For senior professors it might be less relevant.
Relevance outcomes GoNano:
For the post-doc researcher GoNano was very relevant as it give insights based on which she changed her research line and made a new research proposal.
Follow-up activities:
The researcher will apply for different funds with the new proposal (OTP, Lorenz, ERC).
Logical follow-up steps to further align societal needs and values:
For the post-doc researcher it would be nice to have another activity where the adjusted research line could be discussed with different stakeholders. This could be done, for example, by giving them the new research proposal and ask for feedback both on how the research is explained and the content of the research.

INTERVIEW 9 – THE NETHERLANDS– CSO

Meaning of co-creation:
Co-creation is producing 'something' with each other. 'Co' is about doing it together (multiple stakeholders) and creation is about 'producing' something. This 'something' can be a new product or new knowledge.
Evaluation of co-creation activities:
I was present at two stakeholder workshops, the first stakeholder workshop on diabetes and nanotechnology and the second stakeholder workshop on the value of data for the artificial pancreas. I don't have the feeling that what we did with GoNano was exactly co-creation. It felt more like intensive and useful network meetings to me. The reason behind this, is that it is not clear to me what the outcomes of the sessions were, what has been done with them, and who the problem owner was. To me it felt like coming together with a group of people, having interesting discussions, and then going home all with our own lessons learned, but not with further actions to be taken. During the first stakeholder workshop I have the feeling that we indeed did create something for the diagnostic device. Stakeholders with different backgrounds (policy making, businesses, research, and CSO) were brought together and discussed the implementation of the device. I think this was especially relevant for the CEO of the startup working on the device. For instance, after the workshop he contacted me to discuss funding opportunities. Although, we were not able to fund the device right away, we kept in touch and we might provide some funding later this year. The workshop gave the CEO to explain the product to me in his own words, but I think he might have found me perhaps without the workshop as well. The second workshop was more useful for me and for my organization. I was more interested in the subject of this workshop, and the debate on the artificial pancreas approached from two different angles (community-development and commercialized development) gave me useful insights. However, the discussion mostly focused on 'problem definition', and not on the generating a new idea, product, or concept. Although the workshop was useful to me, I don't feel it was really co-creation what we were doing.
Involvement of professional stakeholders in the co-creation process:
I think you had the right mixture of stakeholders was present at both workshop. It was interesting to hear various perspectives from a diverse group of stakeholders. Also, every stakeholder had a connection to diabetes and a general level of knowledge about it, which made in-depth discussions possible. Nevertheless, during the workshops there was no clear problem-owner. It seemed that a diverse group of stakeholder was brought together around a thematic area, diabetes, but not to solve a specific problem. Therefore, we spend quite some time to define a problem together, and did not come to a solution. It could have been better to first define a clear problem, and invite relevant stakeholders that potentially can solve this problem. During the workshop these stakeholders can focus on solutions, instead of defining the problem. For instance, in a hackleton-type of set-up where stakeholders, I heard some great stories that groups of stakeholders came up with a solution in a one-day session. Such a set-up could have been interesting for GoNano as well.
Involvement of citizens in the co-creation process:
In the workshops about diabetes and nanotechnology, I think including diabetes patients, as you did, was very important, and worked out very well. However, with regard to citizens in general, I doubt whether it is useful to include them in the co-creation process. To my notion, only stakeholders should be included in the co-creation process. Citizens are not stakeholders,

they only become stakeholders when if they have a specific stake in the technology. Citizens don't have a stake in diabetes technology, but diabetes patients do. When looking at the results of the citizen consultation, one of the outcomes was the fear of privacy issues and security issues regarding data collected with monitoring device, such as the artificial pancreas. I think this is a narrow minded view on data, and instead on emphasizing the risks we should much more focus on the potential benefits and value of health data.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
My perspective on stakeholder engagement and nanotechnologies hasn't changed much. One thing I learned of participating in the workshops, is that it might be useful to have a problemowner and/or a problem as a starting point. In the GoNano workshops the process was very open, which made it difficult to come to 'real' co-creation activities.
Added value GoNano co-creation process:
The added value of the co-creation process was mostly on getting to know new types of stakeholders. As the workshops were quite intensive, and we had in-depth discussion with each other, I learned about new perspectives on nanotechnology and health and got to knew some interesting people.
Relevance outcomes GoNano:
GoNano was in a number of ways relevant to me: - After the first workshop I came in contact with the CEO of the early diagnostic device and together we explored some funding opportunities (my organization funds new innovations for diabetes technologies). Although, we did not directly managed to fund the technology, we might do this in the future; - Also, after the first workshop I contacted the policy maker and got more information about the regulations on medical devices. - Furthermore, I came in touch with one of the moderators after who introduced me to other people who could help me with moderating an event on diabetes. - After the second workshop I contacted the business developer of the community-based artificial pancreas (based on data), I was very interested in his method and his story behind it. - The second workshop also gave me more insights in how community-based technology works, including the innovation process of it. After this workshop, I did some research and got a lot of insights in community-based technologies. This workshop was a great starting-point for this.
Follow-up activities:
I really don't know what logical follow-up activities would be.
Logical follow-up steps to further align societal needs and values:
In order to come to new products or ideas, it would be good to start with a 'problem' or 'problem owner'.

INTERVIEW 10 – THE NETHERLANDS– BUSINESS REPRESENTATIVE

Meaning of co-creation:
Looking with multiple partners or stakeholders with different expertise from different perspectives to a problem. By looking at this problem together, you come to better solutions.

Evaluation of co-creation activities:
The two stakeholder workshops were interesting, but it as not very clear to me which "problem" we had to or wanted to solve. I felt that the first workshop was a bit more concrete and therefore more useful. We talked there about a data management plan for the artificial pancreas. The second was less specific, and we mainly remained in the conceptualization phase by trying to define the problem and our common goal.
Involvement of professional stakeholders in the co-creation process:
I find it difficult to say which stakeholders should be involved or which stakeholders were missing, because the goal of the co-creation process was not clearly specified. If you first define a clear problem you want to solve, it is much easier to identify the stakeholders that should be present.
Involvement of citizens in the co-creation process:
I am not sure whether citizens in general should be present at the co-creation process, but patients should be definitely present as they bring valuable insights as users of the technology.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
-//-
Added value GoNano co-creation process:
The added value of the co-creation process for me was not very large. In the development of our technology we are dealing with very specific problems, and I had the feeling that the co-creation activities were too general for that. The session would have been useful if they would be centered around our specific issues and challenges, but I understand that this was not the aim of GoNano. We are organizing a table discussion with our company, a policymaker, insurance company and other relevant actors to discuss how the technology that we are developing can be implemented in a faster way in the market. I think such a discussion is relevant for us, as we are currently in this phase of the technology development.
Relevance outcomes GoNano:
Nevertheless, I did get some relevant insights. I learned from perspectives of different types of stakeholders, and how they are looking at technology development in healthcare. One of the stakeholders had a totally different perspective on health technology development than we have, and it was interesting to hear about his perspective. Furthermore, I exchanged contact information with some stakeholders. However, I did not get many new insights in innovation processes, which I hoped to get from these co-creation sessions.
Follow-up activities:
I don't know.
Logical follow-up steps to further align societal needs and values:
I don't know how to answer this question.

INTERVIEW 11 – SPAIN – RESEARCHER 1

Meaning of co-creation:
Co-creation is a process that brings together different actors involved in a theme that is being developed. A new format, methodology or solution to a previous scenario contextualization.

Evaluation of co-creation activities (second stakeholder workshop):
8/10, in terms that the content and the discussions were quite rich and presented good knowledge on co-creation processes and how technologies can be considered in design processes of different natures. For me this is the core output that should come from a workshop and this one was promoting it. I would not rate it as excellent just because the number and variety of participants was not very high – lack of multiple actors weakened the workshop.
Involvement of professional stakeholders in the co-creation process:
I would say that the key stakeholders to be involved are the researchers, designers and developers of nanotechnologies. Also, advanced practitioners (anyone interested in technology) on specific technologies can provide end user feedback.
Involvement of citizens in the co-creation process:
The general public are not essential since they will not provide very enriched contributions to the co-creation process. Members of the public with knowledge of nanotechnology or who could be end-users would be relevant to include. Citizens can contribute in two ways: Assessing the needs for society before identifying the uses of a technology, and evaluating and assessing the design features.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
My personal view of the co-creation process has grown after participating in the workshop. Realised how important the decision-making process in the research process is and how it will affect society's needs and practices. The timeline for technology development from first steps to end-users is too long and trying to understand impacts from the beginning is very positive. Designers (and scientists) start designing with ethical and moral motives and want to improve societal practices from the beginning, and I appreciate this; however, they are not assessing feedback or getting so much feedback. This vision of trying to close the gap [between the start and the end of the technology development] process is positive.
Added value GoNano co-creation process:
Bringing all these reflections in the early steps in the design process for nanotechnologies is essential for having a complete overview of the process, each action, each step, and how it will impact on society. Giving new information to the nanotechnology developers at the early stages can shift some decisions.
Relevance outcomes GoNano:
Yes, specifically related to demonstrating processes. Identified synergies with other stakeholders and discussed demonstrating products/technologies from their project in my own project on plus energy buildings.
Follow-up activities:
Facilitate contact between the two projects – the developers of the building management system and sensor developers – to assess where nanotechnology devices could be included for testing in the latter stages of the project.
Logical follow-up steps to further align societal needs and values:
Include regional and local authorities, public research centres and other communications should develop campaigns and promote interactions with society. Citizen science should be developed to awaken interest from citizens. Raise public awareness of research outcomes and include them in the research process.

INTERVIEW 12 – SPAIN – RESEARCHER 2

Meaning of co-creation:
Co-creation is a method where a project is modified or created from a strong collaboration between the project and potential stakeholders.
Evaluation of co-creation activities (second stakeholder workshop):
The meeting was certainly positive, and I can see it clearly as an example to show the potential for this way of working. The only criticism is that it was lacking the variety of stakeholders as all the participants had similar backgrounds. Nevertheless, we got good feedback on where we can start working and we learned this new way of working through co-creation.
Involvement of professional stakeholders in the co-creation process:
Important to have someone from public administration because it is a difficult connection to establish for scientific projects, and it would be a good way for communicating the project and basic science to the public and demonstrating new technologies. This could be even more important than adoption of the technology at the industrial level, which is difficult to achieve for projects on basic science. Industrial stakeholders could give the project a possibility of surviving through utilization at a technological level and informing industry of innovative concepts is important. Researchers and scientists already included. The younger generation of the public will also be an important audience to include as they will be those affected most by the technologies under development. The older generation of the public will be less relevant as they will be least affected by the technologies under development.
Involvement of citizens in the co-creation process:
An important role for citizens would be to describe how they would receive the technologies: identifying the bias to adopting this technology, which may be motivating or non-motivating.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
I've always been quite convinced by it [nanotechnology development's ability to respond] so opinion hasn't really changed. Even among the scientific stakeholders, concepts were not clearly understood, which was unexpected. This highlights the challenges and the importance of communicating across different backgrounds.
Added value GoNano co-creation process:
It can help understand how to communicate effectively to stakeholders and help to get in touch with potential stakeholders not previously considered relevant. Wider variety of stakeholders will improve the process.
Relevance outcomes GoNano:
Yes, for sure, there were two main points related to communication: (i) that we should pay attention to privacy issues in IOT technology, which we had not considered before as it is not

the central topic of the project but will now try to include somehow; and (ii) putting more emphasis on communicating the basic concepts of the project as there is less familiarity than we anticipated. We've opened up a possible collaboration with a new partner (energy positive buildings project).
Follow-up activities:
We have already contacted the new potential collaborator who was interested in adopting our technology for their project. Nothing has been done yet on including the data privacy topic but we are exploring ways to introduce it in our next public outreach event. Could be interesting to do this as a joint event with GoNano.
Logical follow-up steps to further align societal needs and values:
Encourage meetings between the scientists and diversified publics so that scientist can understand what the needs of each stakeholder group are

INTERVIEW 13 – SPAIN – RESEARCHER 3

Meaning of co-creation:
Co-creation is the process for the development of any new idea or project involving many stages of society.
Evaluation of co-creation activities (citizen workshop and first stakeholder workshop):
I remember the first event being a success even though it wasn't particularly well attended because the participants were very pro-active. The participants at the stakeholder workshop were also very involved but from a different perspective. It was more real and more serious. Scientists were more focused.
Involvement of professional stakeholders in the co-creation process:
At least one or two people from each stage of development: At least one theoretical scientist, one applied scientist, someone from an R&D department at a company (a product developer), a business person, and someone from the government. Anyone that is very far from the field related to the idea under development and anyone that can manipulate the idea for their own gain, i.e. anyone with a conflict of interest, should not be involved.
Involvement of citizens in the co-creation process:
I think citizens should not be involved in the initial stages but more in the following stages where ideas have already been formed. Citizens own ideas are too abstract, so it is more useful to have them offer opinions and react on preformed ideas. Some members of the public can generate good ideas but it is not a common trait. Use the public for validation of the idea rather than its conception.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
I have discovered co-creation. I knew that businesses did market studies for gathering opinion, but I didn't know similar processes could be done in research and development.

I have only interacted with scientists at the stakeholder workshop but I already interreacted with scientists before and my view of them has not changed much. They care [about society], which is good, but that didn't shock me. My views of the citizens changed a lot and this interaction really shocked me. I didn't expect them to be so involved. It was very pleasing to see such a high level of engagement from them.
Added value GoNano co-creation process:
I'm not sure about the value of the citizen workshop. Many ideas were generated but nothing really tangible or realistic. We got problems, necessities and wishes from the general population that nanotechnology can focus on, but no solutions. The scientists in this case haven't changed their research plans to focus on the ideas generated during the stakeholder workshop but if they did pursue the outcomes of the workshop there would be real value in that. Real ideas, real devices, and new technologies could come out of those proposals. I think the possible outcome of the process in general has potential to generate new ideas for the benefit of society.
Relevance outcomes GoNano:
Outcomes from the stakeholder workshop were definitely relevant to me. The smart kitchen concept we discussed at the stakeholder workshop is an idea I'd been thinking about before and hearing positive feedback on it from the other the stakeholders has pushed me toward developing it more in a home project. I am personally developing a robotic cook as a hobby because of the enthusiastic response of the stakeholders.
Follow-up activities:
I have used the outcomes in my personal project but not professionally. My current research field could benefit from automation, but only loosely, so the smart kitchen ideas were less relevant. Other ideas that were proposed are still in my mind and I am leaning towards exploring them further.
Logical follow-up steps to further align societal needs and values:
Ask the people what they want and what they need through a big study (e.g. SDGs from UN) and then align the science system we have to that. Change the metrics of evaluation surrounding research and award funding and reward projects that are not market-driven (cheaper better) but that will benefit society by meeting its needs.

INTERVIEW 14 – SPAIN – RESEARCHER 4

Meaning of co-creation:
As the word suggests, it's creating something together with other people.
Evaluation of co-creation activities (first stakeholder workshop):
I think it was successful in many ways: I really enjoyed it because it was very dynamic and I think we got useful results, and it was also a lot of fun.
Involvement of professional stakeholders in the co-creation process:
Good to have industry – like a product developer – someone from academia, someone from a laboratory, and also citizens.

No stakeholders that are not relevant, I would include everybody – the more stakeholders, the better.
Involvement of citizens in the co-creation process:
I think they can state things related to ethics and interaction [with people]). Nanotechnology is not so well received by the public, which is good, because then we can know better how to develop something that will be well received and that they are not afraid of.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
In my case nothing has changed as a result of being involved in GoNano because in my daily life I also do workshops related to nanotechnology, so it was quite similar to what I already know – nanotechnology development is capable of responding to societal needs and values. I work regularly with scientists and people from academia, and my opinion of them hasn't changed.
Added value GoNano co-creation process:
Innovation and connection between stakeholders. If someone develops something in a lab and it doesn't get to the public then it means nothing. Co-creation events can make this happen.
Relevance outcomes GoNano:
No, not now but maybe something we thought of could be developed in the future, in which case I would be proud of it. We thought of possible applications for the future but I am not a product developer so I don't have a way to develop the ideas we thought of, but I would use them if they were developed.
Follow-up activities:
I am using the methodology but not the ideas we came up with. I work in academia and we use co-creation activities and the GoNano workshop inspired me in this way. I hadn't tried some of the co-creation activities from the GoNano workshop before and now I have used or plan to use them in my own work, e.g. the storyboards.
Logical follow-up steps to further align societal needs and values:
The same steps that the design thinking methodology uses (and the first part of the GoNano workshop) which is definition of the context and ideation, then prototyping, and then implementation. Stakeholders should keep co-creating in their own premises and invite the other stakeholders, e.g. getting the scientists into the manufacturing plant and the developers into the lab. Everybody should adopt a co-creation methodology.

INTERVIEW 15 – SPAIN – RESEARCHER 5

Meaning of co-creation:
I see it as a way to create things but together with people from different fields, and not just scientific fields, but also people who are going to benefit for that creation and people responsible for giving political backing to that creation.
Evaluation of co-creation activities (both stakeholder workshops):
The first one had more opportunities to co-create something and having ideas because it was more like a brain-storming session and the amount of time favoured a dynamic situation.

The second one was too short and would have been better with more participants, but it was interesting because it was a more scientific environment; there was less fantasy. The first one was brainstorming and a lot of fun and the second one was more focused but lacked a little bit of time.
Involvement of professional stakeholders in the co-creation process:
The most important are universities, research centres, and companies. There are a lot of companies that want to do research and collaborate but don't know how to do it and are too focused on time; and the universities are also in their own fantasy bubble and too slow. They should get together more often because it's good for both of them; the mixture can be really good. Politicians should also be more involved because they need to know what is going on and they have the real power to change things. No less relevant stakeholders. There will always be someone that is more or less relevant but it depends on the focus or the situation.
Involvement of citizens in the co-creation process:
I think that right now, citizens are not prepared to really get into co-creation, their ideas are a little too generic or crazy. First you have to get science into schools and maybe develop citizens with more critical minds. Limiting focus on something more achievable could co-create better things. Citizens could be useful in testing. It's really interesting to see how they react to something new: is it understandable, is it easy to use, does it meet their needs, etc. This feedback can be very useful and can give you new ideas and a new way forward. Testing is a very good place for citizens.
Influence GoNano co-creation process on nanotechnologies and other stakeholders:
Not really changed. Being part of a small company, we are already forced to collaborate with universities and institutes, but I realized that when one develops something, one needs to test it on stakeholders to get their opinion. For example, we are developing sensors for a particular field so we are in touch with the people from that field so we can get in their head and meet their needs. The GoNano events helped me realise that these discussions were actually a sort of co-creation process. These engagements with the end users are happening at a middle point in the development process, not so early to be just an idea but early enough to allow changes to be made based on the feedback. My opinion on the stakeholders (mainly researchers) has not changed.
Added value GoNano co-creation process:
Nanotechnology is a very broad field and co-creation is a way for people from different backgrounds to focus on one goal. When you work in a team, the result is always better.
Relevance outcomes GoNano:
The networking was a particularly useful outcome from my involvement in GoNano but none of the research lines or product suggestions were of direct relevance.
Follow-up activities:
I personally plan to use the brainstorming methodology – starting from one idea, expanding to a bigger picture and then narrowing the focus.
Logical follow-up steps to further align societal needs and values:

Getting in touch with political stakeholders. These were lacking at the events I attended. I think we should involve them but in meetings that are not too technical or science focused. However, perhaps after a meeting like the first stakeholder workshop, they would be more prepared for a more focused meeting like the second workshop.